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New species of *Caloca* Mosely (Trichoptera: Calocidae) from eastern Australia

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Abstract

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The Australian endemic genus *Caloca* Mosely was established 60 years ago to include five species. Since then only a single species has been added to the genus. Adult males of seven new species are here named and described: *C. ada* sp. nov., *C. sica* sp. nov., *C. gippslanda* sp. nov., *C. lata* sp. nov., *C. kiandra* sp. nov., *C. disparala* sp. nov. and *C. ungula* sp. nov. Each species possesses a distinct triangular receptacle on the dorsum of the head capsule, which occurs only in *Caloca* and *Pliocaloca* Neboiss. A transient discoidal cell in the hindwing of one species blurs the diagnostic lines between *Caloca* and *Pliocaloca*. However, the two genera can be separated on the presence or absence of spine-like setae associated with segment X (present in *Caloca*), and the larvae of the two genera are distinctive. The descriptions here raise the total number of species in the genus from 6 to 13, all from south-eastern Australia. A key to the identification of all 13 species is provided.

Keywords

Caddisfly, taxonomy, *Caloca*, *ada*, *sica*, *gippslanda*, *lata*, *kiandra*, *disparala*, *ungula*

Introduction

Among the caddisflies (Trichoptera), Calocidae exhibit some of the most interesting morphological features and habitat choices. The hind-wing venation of all Calocidae species is modified, often lacking veins of the cubitus and media. Some species have highly modified maxillary palpi, which may include spines or large setose areas. Most species possess a small finger-like process that extends from the anterior margin of the antennal scape (fig. 11). Unique to the genera *Caloca* Mosely and *Pliocaloca* Neboiss, is a receptacle on the dorsum of the head, which is closed by a membranous cover that opens along the midline (fig. 12). This large, triangular feature holds a pair of filaments that, when the membrane is opened, protrude from the head capsule (fig. 11).

Very little is known about the larvae of *Caloca*. The one species for which a larva has been associated and described is the only known Australian species of Trichoptera to be fully terrestrial. Neboiss (1979) described the larva of *C. saneva* from specimens he collected from pitfall traps placed about 20–50 m from a river. He noted that the adults could be found crawling under leaf litter on the forest floor. This specialised habitat may be the reason why the larvae of other species of *Caloca* remain to be discovered, as the usual technique for collecting larvae is to search river substrates. However, I have personally observed *Caloca* larvae inhabiting a somewhat aquatic environment in seeps along a road cutting in the alpine regions of the Hartz Mountains National Park, Tasmania, which suggests that while some species might not be collected in river samples, they may still require some form of flowing water. Adults of *Caloca* have been collected from 400 m to around 1300 m above sea level. They are found in densely forested or alpine areas with undisturbed ground and shrub layers. Neboiss (1977) recorded the Tasmanian species from alpine areas such as Mt Wellington, the Hartz Mountains and Lake St Clair. The most northerly species has been recorded from Ebor, New South Wales (NSW), where the local Guy Fawkes River runs out of the Guy Fawkes National Park. Two species occur in forested areas of the Blue Mountains, NSW.

Caloca is the most species-rich genus of the family Calocidae, and many of these species appear to be short-range endemics. This apparent endemicity may be a product of sampling effort. However, the present study follows a three-year investigation into the taxonomy of Calocidae, throughout which extensive light trapping and stream sampling around many of the localities of these species were undertaken. Over this period, very few specimens were collected, suggesting that *Caloca* may be rare in the locations in which they occur and have short geographic ranges, they may have very specific emergence and rapid adult life stages, or they may not readily come to light traps. *Caloca* are distributed along the east coast of Australia from Tasmania to northern NSW. The early work of Mosely and Kimmins (1953) and Neboiss (1977) recorded the fauna of NSW, specifically around the Sydney and northern NSW regions,

and the fauna of Tasmania. Many of the new species described here fill the void between these two regions. Six of the new species occur in Victoria, and one of these is also recorded from Mt Gingera in the Australian Capital Territory (ACT). One species occurs in southern NSW, close to the Victorian border near Mt Kosciuszko. Of the previously described species, three are endemic to Tasmania, one is known from Ebor and south of Sydney at Stanwell Park, NSW, one is recorded only from Wentworth Falls, NSW, and one is known to occur across two states, Victoria and NSW.

Caloca was originally erected by Mosely and Kimmins (1953) in the family Odontoceridae Wallengren. In the same publication a description of *Tismana saneva* Mosely, sole member of the monotypic genus *Tismana*, was also included and placed in the family Sericostomatidae Stephens. *Tismana* was later to be synonymised with the genus *Caloca* by Neboiss (1977). It was not until Ross (1967) that the family name Calocidae Ross was erected. Ross (1967) did not provide a family diagnosis. Nor did he state which genera were to be included in this family. His only comments were that the leg spur count was 2, 2, 4, and that the family was little changed from what he called, 'ancestor 15'. It has since been assumed that *Caloca*, likely to be the derivation of Calocidae, belongs within this family (Neboiss, 1977; Johanson and Malm, 2010).

Since Mosely and Kimmins (1953), only a single species has been added to the genus. The current paper adds seven new species to the genus *Caloca*, raising the number of known species to a neat baker's dozen. Here I present descriptions and illustrations of the adult males of these new species, and provide a key for the identification of all adult male *Caloca* species. Given that many *Caloca* appear to have relatively small geographic ranges, and that so many new species are being described, it is likely that there are more species of *Caloca* awaiting collection and description.

Materials and methods

Adult specimens, housed in Museum Victoria, Melbourne, were examined under a Nikon SMZ1500 microscope. Genitalia were cleared in KOH prior to illustrating. Photographs were taken using a Nikon DS-Fi1 camera mounted on a Nikon SMZ1500 microscope. Keys used to identify specimens were those of Neboiss (1986, 1992).

Terminology follows Holzenthal *et al.* (2007). However, in Calocidae the hind-wing venation is highly modified from that of the generalised illustration provided by Holzenthal *et al.* (2007). Here I have applied the terminology of Holzenthal *et al.* (2007), but have interpreted the veins of the hindwing to suit a modification from the generalised pattern (figs 5 and 10). Characters of the genitalia and the tenth abdominal segment (segment X) are indicated in figs 2 and 3.

Family **Calocidae**

Genus ***Caloca*** Mosely, 1953

Type species. *Caloca straminea* Mosely, by original designation, from NSW.

Generic diagnosis

Caloca differ from most other Calocidae in that the males possess a receptacle on the dorsum of the head which houses a pair of membranous filaments; they also possess at least some strong spine-like setae on the genitalia, and lack a distinct discoidal cell in the hindwing, except in *C. disparala* sp. nov., where a small, indistinct discoidal cell is sometimes present in one or both of the hindwings. *Pliocaloca* may be confused with *Caloca* because it also possesses a receptacle on the head. However, members of this genus lack the strong spines on the genitalia, and possess a distinct discoidal cell in the hindwing.

Revised generic description

Adult. Ocelli absent. Male. Head: dorsum with triangular receptacle containing dense, pale setae and a pair of membranous filaments. Antennal scape: with or without projection arising from anterior margin. Maxillary palpi: 5-segmented. Labial palpi: 3-segmented. Forewing: discoidal cell present; forks 1, 2, 3 and 5 present, fork 3 petiolate; nygma between veins R_4 and R_5 and within thyridial cell. Hindwing: discoidal cell present or absent; vein R_1 either fused or parallel to Sc until just beyond midpoint of wing where they fuse for a short distance before separating to approach the wing margin. Legs: spurs 2, 2, 4.

Key to males of *Caloca*

1 Antennal scape without a finger-like process on the anterior surface **2**

– Antennal scape with a finger-like process on the anterior surface (see figs 101-b and 105-b in Mosely and Kimmins, 1953) **3**

2 (1) Segment X longer than wide, gently tapering towards posterior, with anterolaterally directed spines on each lateral margin (see fig. 41-b in Mosely and Kimmins, 1953) ..... ***C. saneva***

– Segment X about as wide as long, with two pairs of stout spines (see fig. 463 in Neboiss, 1977) ..... ***C. ascita***

3 (1) Segment X lateral margins produced distally to form a triangular process at about halfway along length of lateral margin, a single pair of spines dorsally on each process (see fig. 102-b in Mosely and Kimmins, 1953) ..... ***C. straminea***

– Segment X lateral margins not produced distally, with more than one spine on either the dorsal or lateral surfaces **4**

4 (3) Inferior appendages with large spine-like, pointed projections arising from inner surface subapically (figs 19, 20, 23, 24) **5**

– Inferior appendages either without large, strong spines or with spines not subapical on segment **6**

5 (4) Segment X very narrow in apical two-thirds, with dark spines restricted to basal portion (figs 23–25) ..... ***C. gippslanda* sp. nov.**

– Segment X broad, blade-like, with dark spines dorsally along lateral margins (figs 18, 19) ..... ***C. sica* sp. nov.**

6 (4) Inferior appendages each with at least one large spine-like projection medially (figs 7, 14) **7**

– Inferior appendages without any large spine-like projections medially (figs 19, 24, 29) **8**

7 (6) Inferior appendages each with one large medial spine-like projection; segment X lateral margins slightly divergent towards posterior until apical third, then angled in, with about six long setae dorsolaterally along length of segment, and a pair of strong setae on dorsal face at about mid length (figs 13–15) ..... ***C. lata* sp. nov.**

– Inferior appendages each with one ventral and three large medial spine-like projections; segment X lateral margins slightly converging towards posterior then rounded in apical third, without spines dorsally but with a row of lateral spines in distal half (figs 6–8) ..... ***C. kiandra* sp. nov.**

8 (6) Segment X elongate and tapered, with medial incision greater than half the length of the segment (figs 1, 33) **9**

– Segment X broad, with medial incision less than half the length of the segment (fig. 28) **12**

9 (8) Segment X with spines restricted to apical one-third (figs 33, 34) **0**

– Segment X with at least some spines around half the length of the segment (figs 1, 2, 28) **11**

10 (9) Segment X with one large, stout ventral spine and two slender lateral spines; inferior appendages broad in ventral view (figs 33, 34) ..... **C. *disparala* sp. nov.**

– Segment X with three dorsal spines and one ventral spine; inferior appendages, in ventral view, much narrower in apical half (see fig. 105-d and e in Mosely and Kimmins, 1953) ..... ***C. eba***

11 (9) Segment X with one very long anterolaterally directed spine on lateral margin at about halfway along length, one very long laterally directed spine on lateral margin at about two-thirds length, one long spine on ventral margin, directed laterally from the segment but bent halfway to face posteriorly, and a small spine on the dorsal margin subapically; inferior appendages without medial projections (see fig. 106-c and d in Mosely and Kimmins, 1953 ..... ***C. fallia***

– Segment X with three or four spines laterally about halfway along length of segment; apices of inferior appendages broadly incised, inner process stout, pointed and shorter than outer process (figs 1–3) ..... ***C. ungula* sp. nov.**

12 (8) Segment X with row of dark spines on lateral margins, a pair of dark spines on dorsal surface at about two-thirds length of the segment, and no spines apically; inferior appendages without medial processes (figs 28, 29) ..... ***C. ada* sp. nov.**

– Segment X with dark spines apically; inferior appendages each with medial process (see fig. 104-c and e in Mosely and Kimmins, 1953) ..... ***C. tertia***

***Caloca ungula* sp. nov.**

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Figures 1–5

Holotype male: Vic.: Mt Feathertop, 1300 m, 12 Feb 1984, G. Theischinger. **T-21490**.

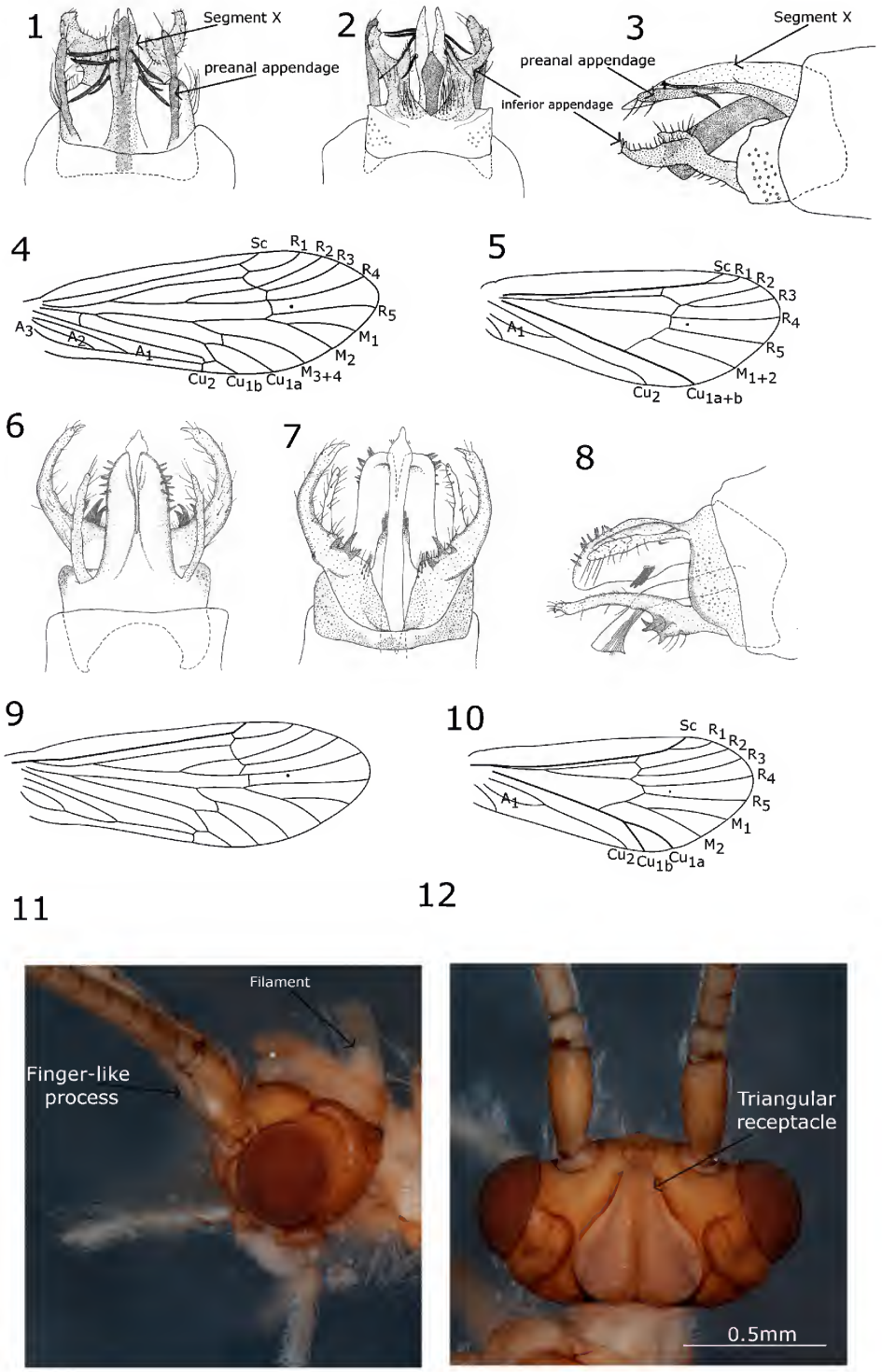
Paratypes: ACT: Mt Gingera, 11 Jan 1967, E.F. Riek. **T-21491**, 1 male. NSW: Perisher Creek, 1500 m, 5 Jan 1984, G. Theischinger. **T-21492**, 2 males (1 illustrated).

Diagnosis. This species can be separated from other species of *Caloca* by the 3–4 spines arranged laterally around the midpoint of segment X, and the apices of the inferior appendages being broadly incised.

Description. Adult male. Length of anterior wing: 5–5.7 mm ($n = 4$). Head: postocular warts long, relatively wide; anterior warts slightly raised, semicircular, abutting to form a circle; a pair of large warts on frons anterior and medial to antennae. Antennae: as long as anterior wing; scape approximately as long as depth of head capsule, with a process arising from the basal half and extending to the distal margin. Maxillary palpi: covered in setae, dorsal surface of first three segments with long setae; segments 4 and 5 about three-quarters length of other segments. Forewing (fig. 4): thyridial cell present; fork 3 petiolate; cross-vein m-cu between MP and Cu_{1a} distal to where MA and MP separate and where Cu_{1a} separates from Cu_{1b}; Cu_2 joins Cu_{1b} via cross-vein; A_1 joins Cu_2 at arculus. Hindwing (fig. 5): vein R_1 parallel to Sc until just beyond midpoint of wing where they fuse for a short distance before separating to approach the wing margin; fork 1 on short pedestal; fork 3 absent; veins M_1 and M_2 fused; basal section of vein M absent; vein Mp absent; Cu_{1a} and Cu_{1b} fused; Cu_2 absent. Genitalia (figs 1–3): segment X narrow, incised apically to about half length of segment, each apical projection with two or three long spines dorsally and one long spine ventrally at about the midpoint of segment; preanal appendages almost as long as segment X; inferior appendages, apices broadly incised with inner process stout, pointed and shorter than outer process; phallus in ventral view diamond-shaped apically.

Female and immature stages unknown.

Etymology. From the Latin *ungula* meaning 'claw' and pertaining to the claw-like inferior appendage.



Figures 1–12. *Caloca ungula*, male (1–5): genitalia, dorsal (1), ventral (2), lateral (3); forewing (4); hindwing (5). *C. kiandra*, male (6–12): genitalia, dorsal (6), ventral (7), lateral (8); forewing (9); hindwing (10); head, lateral (11), dorsal (12).

***Caloca kiandra* sp. nov.**

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Figures 6–10

Holotype male. NSW: Diggers Ck, Mt Kosciusko, 9 Dec 1974, E.F. Riek. **T-21493**, 1 male.

Paratypes. Collected with holotype: **T-21494**, 1 male. **T-21495**, 1 male.

Other material examined. NSW: Alpine Ck, Kiandra, 9 Dec 1964, E.F. Riek. **TRI-26656**, 27 males. **TRI-26417**, 6 males. **TRI-26420**, 1 male. NSW: Alpine Ck, Kiandra, 19 Dec 1962, **TRI-26151**, 5 males (1 illustrated).

Diagnosis. This species can be separated from other species of *Caloca* by the presence of three large medial spines and one large ventral spine arising medially from each inferior appendage at about mid length.

Description. Male. Length of anterior wing: 5.5–6.2 mm (n = 42). Head: anterior setal warts, small, separated; a pair of large warts on frons anterior and medial to antennae; frons with apical margin projected forward slightly; antennae about as long as anterior wing length; scape about as long as depth of head capsule, with setose projection arising from basal half and extending to distal margin. Maxillary palpi with setae on dorsal surface longer than ventral. Pronotum: with one large pair of setose warts. Mesoscutellum: with darker pigmentation in anterolateral corners. Forewing (fig. 9): covered in brown setae; fork 3 petiolate; cross-vein m-cu between MP and Cu_{1a}, placed distally to where MA and MP separate and where Cu_{1a} separates from Cu_{1b}; Cu_2 joins Cu_{1b} via cross-vein; A_1 meets Cu_2 at arculus. Hindwing (fig. 10): veins R, Rs and M very faint; fork 1 and 2 sessile; fork 3 on pedestal; fork 5 present; veins M_{3+4} and Cu_2 absent; cross-vein between Cu_1 and A_1 near base of wing; nygma between veins R_4 and R_5. Genitalia (figs 6–8): segment X broad, narrowly and deeply incised apically, with row of dark spines along lateral margins in distal half of apices, ventral surface broad, concave with about three dark spines projecting posteriorly at about mid length of segment in medial quarter; preanal appendages long, slender, about three-quarters length of segment X, gently curved inwards; inferior appendages curved inwards, apices pointed, with three large medial spines and one large ventral spine arising at about the midpoint of segment.

Female and immature stages unknown.

Etymology. Named after the type locality.

***Caloca lata* sp. nov.**

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Holotype male. Vic.: Ovens R at Porepunkah, 26 Jan 1960, A. Neboiss. **T-21496**.

Paratypes. Collected with holotype: **T-21497**, 1 male. **T-21498**, 1 male.

Other material examined. Vic.: Ovens R at Porepunkah, 26 Jan 1960, A. Neboiss. **TRI-26413**, 1 male. **TRI-26415**, 1 male. **TRI-26414**, 2 males. **TRI-6470**, 1 male (illustrated). Vic.: Buffalo R, Abbeyards, 27 Jan 1960, A. Neboiss. **TRI-26412**, 2 males. Vic.: Lake Mountain, 17 Jan 1961, A. Neboiss. **TRI-26411**, 1 male. **TRI-26416**, 3 males.

Figures 13–17

Diagnosis. This species can be separated from other species of *Caloca* by the presence of a large medial spine on the inferior appendage.

Description. Adult male. Length of anterior wing: 5.3–6.2 mm (n = 14). Head: postocular setal warts long, narrow; row of setae above eye; strong, pale and darker setae posterior to eye; a pair of large warts on frons anterior and medial to antennae. Maxillary palpi, setose, setae on dorsum relatively long. Antennae: shorter than anterior wing length; antennal scape relatively long, with slender projection arising anteriorly at about mid length, extending almost to anterior margin of scape. Forewing (fig. 16): discoidal and thyridial cells present; cross-vein between Sc and R_1; vein A_1 joins Cu_2 at arculus. Hindwing (fig. 17): vein R_1 parallel to Sc until just beyond midpoint of wing where they fuse for a short distance before separating to approach the wing margin; forks 1 and 2 sessile; fork 5 present; veins Cu_2 and MP absent; basal half of vein MA weak, giving the appearance of a large vein-free area in mid basal half of wing. Genitalia (figs 13–15): segment X broad, lateral margins slightly divergent until apical third where they converge at approximately a 45° angle, apical third incised medially, pair of lobes basally on lateral margin, dorsal sublateral margins with a row of about seven spines projecting distally, extending from lobe to apical quarter, and one spine situated more medially at about the midpoint of segment, directed posteriorly; preanal appendages slender, extending almost length of segment X, basal third weakly curved outwards; inferior appendages with two broad, spine-like projections, lateral projection weakly curved inward, abruptly tapering to a point, darkly sclerotised apically, and medial projection shorter, blade-like, angled medially (one specimen possesses a third projection between these two that is about half the length of the medial projection).

Female and immature stages unknown.

Etymology. From the Latin *lata* meaning 'wide' and pertaining to the broad segment X.

***Caloca sica* sp. nov.**

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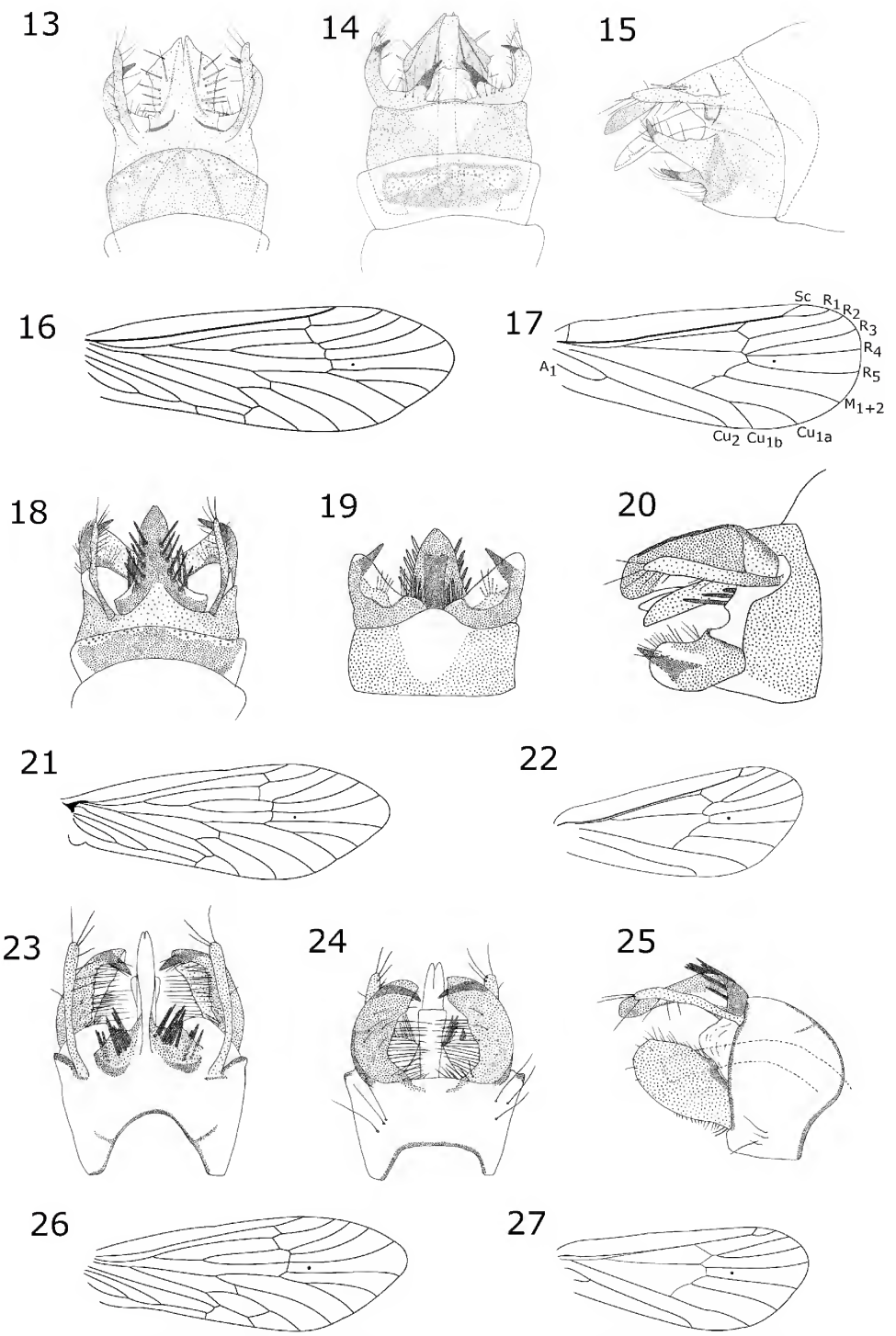
Figures 18–22

Holotype male. Vic.: Thomson R, 7 km NNW Walhalla (Narrows Gauging Stn), 4 Mar 1980, NMV Survey Dept TRS Site T16. **T-21499**.

Paratypes. Vic.: Britannia Ck, 6 km S of Warburton, 27 Feb 1976, Neboiss. **T-21500**, 1 male. **T-21501**, 1 male (illustrated).

Diagnosis. This species can be separated from other species of *Caloca* by the transparent ventral half of the inferior appendages, which gives them a concave appearance in ventral view.



Figures 13–27. *Caloca lata*, male (13–17): genitalia, dorsal (13), ventral (14), lateral (15); forewing (16); hindwing (17). *C. sica*, male (18–22): genitalia, dorsal (18), ventral (19), lateral (20); forewing (21); hindwing (22). *C. gippslanda*, male (23–27): genitalia, dorsal (23), ventral (24), lateral (25); forewing (26); hindwing (27).

Description. Adult male. Length of anterior wing: 5.5–5.6 mm (n = 3). Head: postocular setal warts long, narrow; a pair of large warts on frons anterior and medial to antennae. Maxillary palpi, with long setae dorsally. Antennae: shorter than anterior wing length; antennal scape about as long as first three antennal segments, with slender projection arising anteriorly at about mid length, extending to one-seventh scape length from anterior margin of scape. Pronotum: with one small pair of medial setal warts and one larger pair of distal setal warts. Forewing (fig. 21): discoidal and thyridial cells present; cross-vein between Sc and R_1; fork 1 sessile; fork 3 petiolate; vein Cu_2 weak; vein A_1 joins Cu_2 at arculus. Hindwing (fig. 22): vein R_1 and Sc fused along length until separating just before wing margin; fork 1 on small pedestal; fork 2 sessile. Abdomen: segment 9 ventrally with distinct light patch, broadly along midline for length of segment. Genitalia (figs 18–20): segment X in dorsal view broad basally, posterior three-quarters somewhat elongate and triangular, tapering distally; dorsolateral margins with row of six strong setae directed posterodistally; segment X ventrally with three pairs of strong setae in line with phallus, directed posteriorly; preanal appendages long, slender, extending almost length of segment X; inferior appendages somewhat short; in ventral view widely separated, medially with slightly projecting setose lobe, posterior half, from setose lobe to distal margin, transparent, giving medial margin of appendages a concave appearance; inner surface concave, with large posteromedially directed spine extending beyond posterior margin of each inferior appendage.

Female and immature stages unknown.

Etymology. From the Latin *sica* meaning 'dagger' and pertaining to the dagger-like segment X.

Caloca gippslanda sp. nov.

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Figures 23–27

Holotype male. Vic.: Goonmark Rocks scenic reserve, E. Gippsland, 16 Jan 1991, G. Theischinger. **T-21509**.

Paratype. Collected with holotype: **T-21510**, 1 male (illustrated).

Diagnosis. This species can be separated from other species of *Caloca* by the very narrow posterior half of segment X, which bears no spine-like setae, and the broad anterior half, which bears several dark spine-like setae on the dorsum.

Description. Adult male. Length of anterior wing: 6.5–7 mm (n = 2). Head: postocular warts long, narrow, slightly broader dorsally; anterior setal warts rounded, raised, separated anteriorly, abutting posteriorly; a small, distinct, white puncture medially and anterior to anterior setal warts; a pair of large warts on frons anterior and medial to antennae. Antennae: slightly shorter than anterior wing length; scape about as long as pedicel and first two antennal segments combined, with relatively small projection on anterior surface arising from mid length and terminating just before distal margin of scape. Maxillary palpi: with long setae on dorsal surface of first three segments, last two segments with short setae. Pronotum: with one pair of large, distal setal warts and one pair of small medial setal warts. Forewing (fig. 26): forks 1 and 2 sessile, fork 3 petiolate, fork 4 absent; cross-veins s and r_4-r_5 forming relatively straight line; cross-vein r-m angled medially from r_4 to r_5 at about 45°; cross-vein m absent, medial cell open; cross-vein m-cu distal from separation of Cu_{1a} and Cu_{1b}; cross-vein present between Cu_{1a} and Cu_{1b}; Cu_2 terminates at cross-vein between Cu_{1b} and A_1; vein A_1 terminates at wing margin slightly basad of Cu_2 termination point; small cross-vein present between A_1 and wing margin just distal to confluence of A_1 with A_2; nygma present in fork 2, absent in thyridial cell. Hindwing (fig. 27): Sc and R_1 fused almost along entire length until separating just before wing margin; fork 1 present on very short pedestal; fork 2 sessile, with nygma; M_1 and M_3 fused, basal section of M absent; Cu_{1a} and Cu_{1a} fused; Cu_2 absent; A_2 joins A_1 close to base of wing. Abdomen: segment 9 ventrally with distinct light patch, broad posteriorly and converging anteriorly before reaching anterior margin. Genitalia (figs 23–26): segment X anterior half broad, with several (8–10) strong, dark, posteriorly projecting spines on posterior half of dorsal surface and 3–4 strong, dark, posteriorly projecting spines on anterior half of ventral surface; posterior half slender, with two ridges slightly diverging posteriorly; preanal appendages slender, about as long as segment X; inferior appendages in lateral view broad, ventral surface rounded, dorsal surface somewhat straight; in ventral view apices directed medially, inner surface concave with large tapered spine subapically, ventral and dorsal margins with strong medially directed setae. Phallus: simple, slightly sclerotised on ventral and lateral surfaces, phallotremal sclerite present laterally at about three-quarters length.

Female and immature stages unknown.

Etymology. Named after the region of the type locality.

Caloca ada sp. nov.

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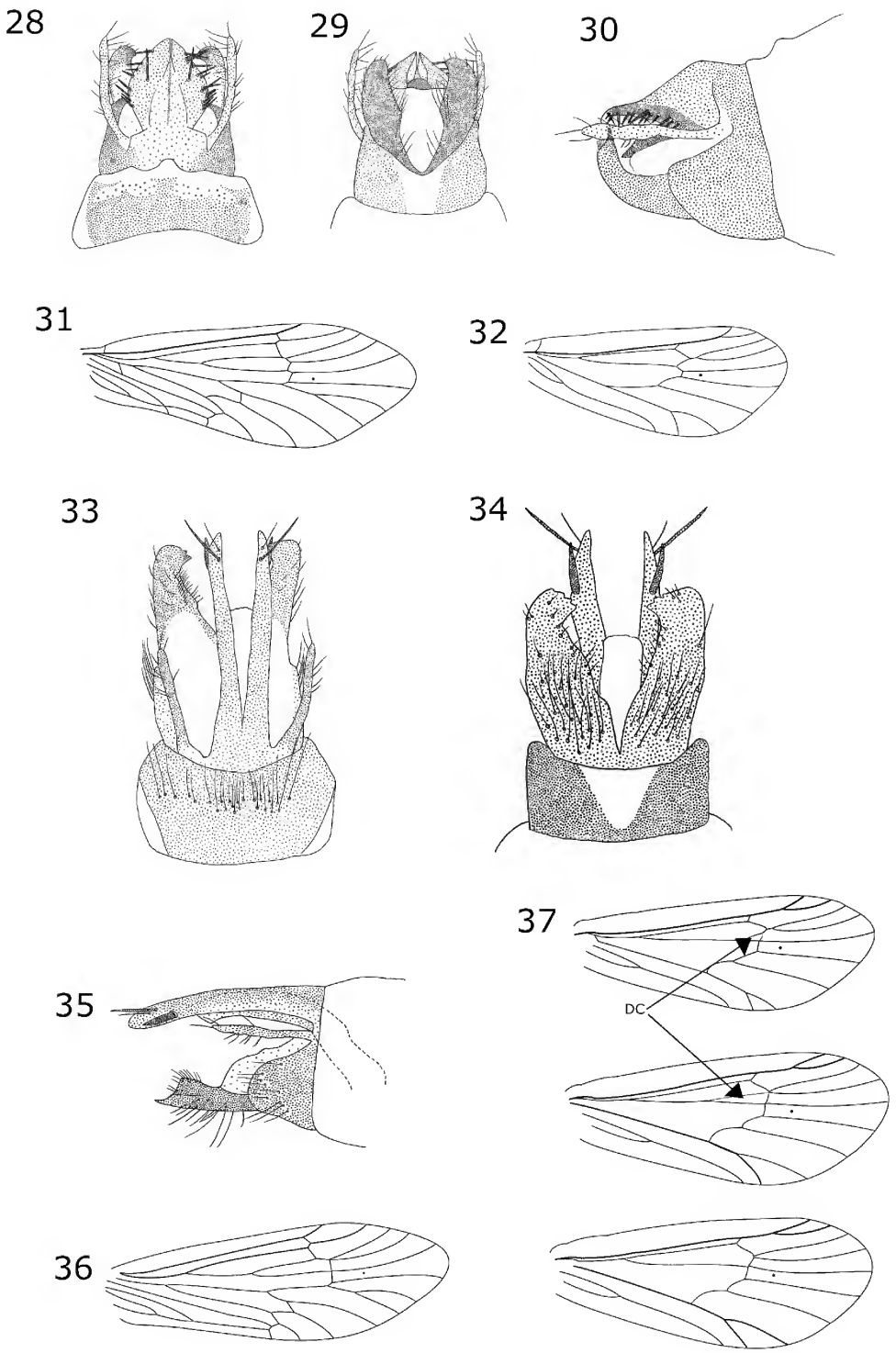
Figures 28–32

Holotype male. Vic.: Ada R on Ada R Rd, S4, La Trobe C Survey 37°50.8'S 145°52'E, 19 Jan 1979. **T-21502**.

Paratype. Vic.: Dandenong Mts, Sassafras Ck, 18 Nov 1972, P. Zwick. **T-21503**, 1 male (illustrated).

Diagnosis. This species can be separated from other species of *Caloca* by the shape of segment X, which in dorsal view is broad at the anterior margin, expanding out laterally towards the posterior until the midpoint, where the lateral margins are rounded and gradually converge to a posterior point.

Description. Adult male. Length of anterior wing: 6.5–6.8 mm (n = 2). Head: postocular setal warts long, narrow; anterior setal warts abutting; a pair of large warts on frons anterior and medial to antennae. Maxillary palpi (broken in both specimens), first three segments with dense, long setae dorsally. Antennae: broken in both specimens; antennal scape



Figures 28–39. *Caloca ada*, male (28–32): genitalia, dorsal (28), ventral (29), lateral (30); forewing (31); hindwing (32). *C. disparala*, male (33–39): genitalia, dorsal (33), ventral (34), lateral (35); forewing (36); variations of the hindwing (37–39).

about as long as first three antennal segments, with slender projection arising anteriorly at about mid length, extending to anterior margin of scape. Pronotum: with one small pair of medial setal warts and one larger pair of distal setal warts. Forewing (fig. 31): discoidal and thyridial cells present; cross-vein between Sc and R_1; fork 1 sessile; fork 3 petiolate; vein A_1 joins Cu_2 at arculus; cross-vein between A and wing margin present at confluence of A_1 and A_{2+3}. Hindwing (fig. 32): vein R_1 parallel to Sc until just beyond midpoint of wing where they fuse for a short distance before separating to approach the wing margin; fork 1 on small pedestal; fork 2 sessile; cross-vein present between M and Cu_1. Abdomen: segment 9 ventrally with distinct light patch, broadly along midline for length of segment. Genitalia (figs 28–30): segment X in dorsal view basally broad, rapidly expanding laterally towards posterior until the midpoint, then gradually tapering to point, with a distinct ridge along midline and lesser ridges to either side, lateral margins rounded with row of strong posterolaterally and laterally directed spines, with a pair of posteriorly directed spines on dorsum at about the midpoint, posterior one-sixth narrowly incised; preanal appendages long, slender, extending just beyond length of segment X; inferior appendages about as long as segment X; in lateral view apical quarter sharply upturned, terminating in a dorsally directed point.

Female and immature stages unknown.

Etymology. Named after the type locality.

***Caloca disparala* sp. nov.**

urn:lsid:zoobank.org:act:5C9EFF64-E527-4338-957B-B2841BCEEB61

Figures 33–39

Holotype male. Vic.: Cumberland Falls, Marysville, 1067 m, 37°30'S 145°50'E, 18 Jan 1952, A. Neboiss. **T-21504**.

Paratypes. Vic.: Cumberland Falls, Marysville, 1067 m, 37°30'S 145°50'E, 8 Jan 1952, A. Neboiss. **T-21505**, 1 male (illustrated). Vic.: Mt Baw Baw, 1555 m, 13 Jan 1966, B. Cantrell. **T-21506**, 1 male. **T-21507**, 1 male. **T-21508**, 1 male.

Diagnosis. This species can be separated from other species of *Caloca* by the presence of a very broad, spine-like setule subapically on the ventral surfaces of each process of segment X.

Description. Adult male. Length of anterior wing: 5.8–7.2 mm (n = 5). Head: postocular setal warts long, narrow; anterior setal warts, raised and abutting; a pair of large warts on frons, anterior and medial to antennae. Maxillary palpi with medium length setae on dorsal surface. Antennae: about as long as forewing length; antennal scape about as long as first three antennal segments, with slender projection arising anteriorly in basal third, extending to anterior margin of scape, with dense tuft of setae between scape and projection. Pronotum: with one small pair of medial setal warts and one larger pair of distal setal warts. Forewing (fig. 36): discoidal and thyridial cells present; discoidal cell long; cross-vein between Sc and R_1; fork 1 sessile; fork 3 petiolate; vein A_1 joins Cu_2 at arculus. Hindwing (figs 37–39): discoidal cell, either small (fig. 37) or long (fig. 38), present in one or both of the hindwings, or absent (fig. 39); vein R_1 parallel to Sc until R_1-R_2 cross-vein where they fuse for a short distance before separating to approach the wing margin; fork 1 either on small pedestal or sessile; fork 2 sessile; cross-vein present between M and Cu_1; base of M absent. Abdomen: segment 9 ventrally with distinct, triangular light patch; in lateral view rounded posteriorly and extended to reach around half length of segment X. Genitalia (figs 33–35): segment X in dorsal view long and slender, deeply incised almost to base of segment; a large, broad spine-like seta subapically on lateral surface; a long, pale slender seta subapically on dorsal surface; a darker long, slender seta anterior to pale seta on dorsal surface; preanal appendages long, slender, extending to just beyond mid length of segment X; inferior appendages terminating just before length of segment X; in lateral view ventral margin relatively straight, dorsal margin with distinct, rounded rise above mid two-thirds, apically pointed; in ventral view broad, slightly converging towards posterior, apex rounded, inner apical margin with two small pointed teeth.

Female and immature stages unknown.

Etymology. From the Latin *dispar* meaning 'imperfectly matched' and *ala* meaning 'wing' and pertaining to the variation of the hindwings between and sometimes within specimens.

Remarks

In the original generic description, given by Mosely and Kimmins (1953), the adult males are said to be lacking a discoidal cell in the hindwing. However, a discoidal cell is, variably, present in *C. disparala*. The presence of a discoidal cell was the main diagnostic feature used to distinguish the genus *Pliocaloca* Neboiss, from other genera of Calocidae. This character can no longer be said to be a diagnostic feature for *Pliocaloca*. However, many of the larval characters of *Pliocaloca*, as described in Shackleton (2010), are diagnostic for this genus.

Acknowledgements

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Revision of *Alloxysta* from the Curtis collection (Hymenoptera: Figitidae: Charipinae) deposited in Museum Victoria (Australia)

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Abstract

Ferrer-Suay, M., Selfa, J., Alonso-Zarazaga, M.A. and Pujade-Villar, J. 2013. Revision of *Alloxysta* from the Curtis collection (Hymenoptera: Figitidae: Charipinae) deposited in Museum Victoria (Australia). *Memoirs of Museum Victoria* 70: 11–16.

Alloxysta types from the Curtis collection have been examined. Three species of this genus are deposited in Museum Victoria: *Alloxysta fulviceps* (Curtis, 1838), *A. pallidicornis* (Curtis, 1838) and *A. pedestris* (Curtis, 1838). *A. fulviceps* was treated in a previous work. *A. pallidicornis* and *A. pedestris* are here considered valid species. Redescription and complete plates are presented for each species.

Keywords

Charipinae, *Alloxysta*, Curtis, Museum Victoria

Introduction

Subfamily Charipinae, with its many described species, has always been characterised by problematic taxonomy. In some cases the borders between species are not very clear. This subfamily comprises very small wasps with smooth and shiny bodies. Eight different genera are currently considered valid: *Alloxysta* Förster, 1869 (cosmopolitan), *Apocharips* Fergusson, 1986 (Palaearctic and Neotropic), *Dilapothor* Paretas-Martínez and Pujade-Villar, 2006 (Australia), *Dilyta* Förster, 1869 (cosmopolitan except Australia), *Lobopterocharips* Paretas-Martínez and Pujade-Villar, 2007 (Nepal), *Lytoxysta* Kieffer, 1909 (North America), *Phaenoglyphis* Förster, 1869 (cosmopolitan) and *Thoreauana* Girault, 1930 (Australia).

Alloxysta is the most speciose genus within this subfamily, with more than 100 valid species (Ferrer-Suay *et al.*, 2012a). They are widely distributed throughout the world. *Alloxysta* is a very complicated genus with a large number of species that are very difficult to identify, their small size and few diagnostic features making this task difficult. The most important characters for distinguishing between *Alloxysta* species are: (i) proportion of flagellomeres; (ii) presence or absence of pronotal carinae; (iii) presence or absence of propodeal carinae, and, if present, their shape; and (iv) size and shape of the radial cell. *Alloxysta* species are hyperparasitoids of aphids *viz* Aphidiinae (Hymenoptera: Ichneumonoidea: Braconidae) and Aphelininae (Hymenoptera: Chalcidoidea: Aphelinidae). The first step in revising each species is to examine the type material on which the original descriptions are based to determine whether the species can be considered valid. Recently, other important collections of the genus *Alloxysta* have been studied: the Belizin collection deposited at the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia (Ferrer-Suay *et al.*, 2012b); the Ionescu collection deposited at the 'Grigore Antipa' National Museum of Natural History, Bucharest, Romania (Ferrer-Suay *et al.*, 2012c); the Thomson and Zetterstedt collections deposited at the Lund Museum of Zoology, Sweden (Ferrer-Suay *et al.*, 2013); the Hartig collection deposited at the Zoologische Staatssammlung Museum, München, Germany (Ferrer-Suay *et al.*, in prep.); the Hellén collection deposited at the Finnish Museum of Natural History, Helsinki, Finland (Ferrer-Suay *et al.*, in prep.); the Cameron and Fergusson collections deposited at the British Museum (Natural History), London, England (Ferrer-Suay *et al.*, in prep.); and the Andrews, Ashmead and Baker collections deposited at the United States National Museum of Natural History (Smithsonian Institution), Washington DC, USA, and at the Canadian National Collection of Insects, Ottawa, Canada (Ferrer-Suay *et al.*, in press).

Only three species of those deposited in Curtis's collection at Museum Victoria (MV) belong to *Alloxysta*: *A. fulviceps*

(Curtis, 1838), *A. pallidicornis* (Curtis, 1838) and *A. pedestris* (Curtis, 1838). *Alloxysta fulviceps* was treated in a previous work (Pujade-Villar *et al.*, 2011). Here the other two *Alloxysta* species are revised and considered to be valid. A redescription and a complete plate of each species are presented.

Material and methods

To preserve type material specimens they were studied using stereomicroscopy (NIKON SMZ-1), and photographed in a Zeiss Discovery V8 compound microscope with an attached INFINITYX-21C digital camera that fed image data to a notebook or desktop computer; the program DeltaPix View-Pro AZ was then used to merge an image series (typically representing 20 focal planes) into a single in-focus image.

All photographs have been taken from type specimens. The decision of whether to consider *A. pallidicornis* and *A. pedestris* as valid species was taken after comparing them with known *Alloxysta* species. In the *A. pedestris* plate, the male antenna is covered by glue so the boundaries between flagellomeres have been marked to allow easier differentiation.

The morphological terms used are drawn from Paretas-Martínez *et al.* (2007). Abbreviations for the first and subsequent flagellomeres are F1–F12. Measurements in antennal formulae are given as length (width); these are listed from pedicel to F4. The width of the forewing radial cell is measured from the margin of the wing to the beginning of the Rs vein. The transfacial line is the distance between the inner margins of the compound eyes, measured across the face through the antennal sockets, divided by the height of the eye. The malar space is the measured distance from the lower part of the gena from the mouthparts to the ventral margin of the compound eye, divided by the height of the eye. Females and males of the species described have the same characters except where indicated in the redescriptions.

Results and discussion

Alloxysta pallidicornis (Curtis, 1838)

Figure 1

Combinations of *Cynips pallidicornis* Curtis, 1838 (Curtis, 1838, p. 688); *Alloxysta pallidicornis* (Curtis) Quinlan and Fergusson, 1981 (Quinlan and Fergusson, 1981, p. 254).

Type material of *Cynips pallidicornis* Curtis. Lectotype ♀ (deposited in MV) with the following labels: 'Holotype' (round label with red margins), 'Holotype of *Cynips pallidicornis* Curt. det. Fergusson and Quinlan 1980', '*Alloxysta forticornis* (Gir.) ♀ det. J. Quinlan, 1980', 'MUS. VIC. ENTO 2011-IIL' (green label), 'Lectotype *Cynips pallidicornis* Curtis ♀ design. M. Ferrer-Suay 2013', '*Alloxysta pallidicornis* (Curtis, 1838) ♀ M. Ferrer-Suay det. 2011'.

Redescription

Colouration. Head yellowish brown; mesosoma and metasoma dark brown; scape brown, pedicel and all flagellomeres yellowish brown; legs and veins yellowish brown.

Head. Transversally ovate, smooth and shiny, slightly wider than high in front view; with setae below, between and a few above toruli; with few setae on vertex and with many setae on face; transfacial line 1.2 times height of eye; malar space 0.6 times height of eye (fig. 1c).

Antenna. Female: 13-segmented, filiform; all antennomeres covered with sparse setae; F1 thinner and smoother than remaining flagellomeres, F2–F11 with rhinaria and club shaped; antennal formula: 2.3 (1.6); 6.5 (1.2); 4.5 (1.5); 4.0 (1.5); 4.0 (1.5) (fig. 1d). Male unknown.

Mesosoma. Pronotum entirely covered by setae, with two long, thick carinae clearly visible (fig. 1e); mesoscutum smooth and shiny, round in dorsal view with scattered setae; scutellum also smooth and shiny with scattered setae, which are more abundant on apex of scutellum; height of mesopleural triangle along anterior margin 1.6 times height of mesopleuron; propodeum covered with abundant pubescence, with carinae well defined and separated by setae in anterior half and forming a plate in posterior half (fig. 1f).

Forewing. Longer than body, 1.4 times as long as mesosoma and metasoma together (fig. 1a); covered with dense pubescence; marginal setae present. Open radial cell, 2.6 times as long as wide; R1 short and slightly curved; Rs long and also slightly curved (fig. 1b).

Metasoma. Anterior part with an incomplete ring of setae, glabrous at centre, wider laterally; metasoma smooth and shiny, T3 and T4 clearly visibly distinguished.

Distribution. Holarctic.

Comments. According to Quinlan and Fergusson (1981), *Alloxysta pallidicornis* (Curtis) is represented in the Curtis collection by four specimens, but only one fits the original description; the other three are *Synergus* species. Quinlan and Fergusson's (1981) 'holotype' designation is to be considered a lectotype designation according to Article 74.6 of the International Code of Zoological Nomenclature (ICZN, 1999), since the original description gives no information about the number of specimens used by Curtis for his description. We hereby consider this specimen to be a lectotype.

Alloxysta pedestris (Curtis, 1838)

Figure 2

Combinations of *Cynips pedestris* Curtis, 1838 (Curtis, 1838, p. 688); *Allotria pedestris* (Curtis) (Cameron, 1886, p. 88); *Nephycta pedestris* (Curtis) (Kieffer, 1900, p. 114); *Alloxysta pedestris* (Curtis) (Hellén, 1963, p. 19).

Type material of *Cynips pedestris* Curtis. Lectotype ♂ designated by Quinlan and Fergusson (1981, p. 255) (deposited in MV) with the following labels: 'Lectotype' (round label with blue in the margin), 'Holotype of *Cynips pedestris* Curt. det. Fergusson and Quinlan 1980', 'ENT-936', '*Alloxysta pedestris* (Curtis, 1838) ♂ M. Ferrer-Suay det. 2011'. Paralectotype with the following labels: 'Paralectotype' (round label with blue in the margin), 'Type' (round label with red in the margin), 'Type of *Cynips pedestris* Curt., G.J. Kerrich det. 1948, = *Pezophycta p.* ♀', 'MUS. VIC. ENTO 2011-IIL' (green label), '*Alloxysta pedestris* (Curtis, 1838) ♀ M. Ferrer-Suay det. 2011'.

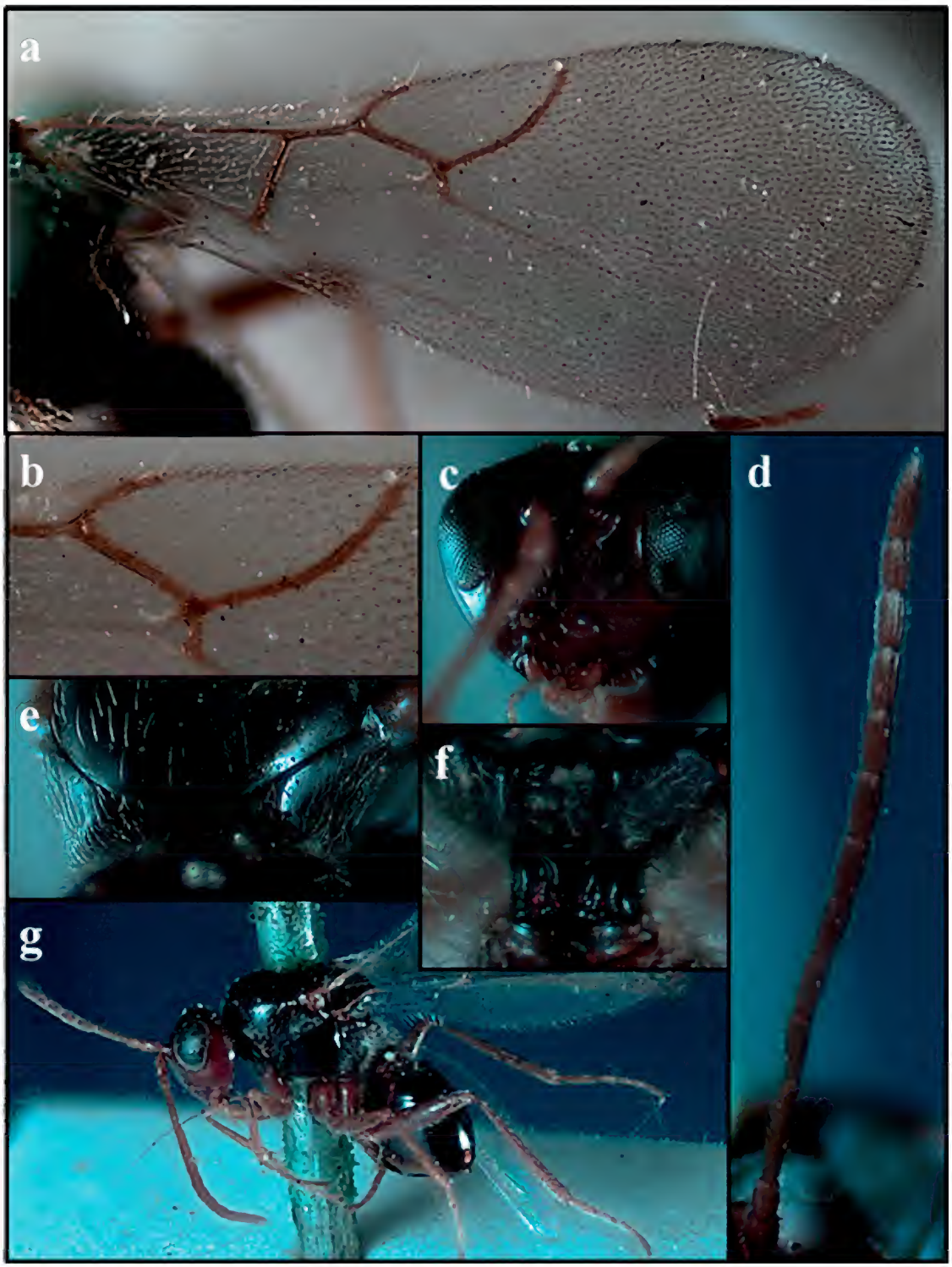

Figure 1. *Alloxysta pallidicornis* (Curtis, 1838): (a) forewing; (b) radial cell; (c) head; (d) antenna; (e) pronotum; (f) propodeum; (g) body.

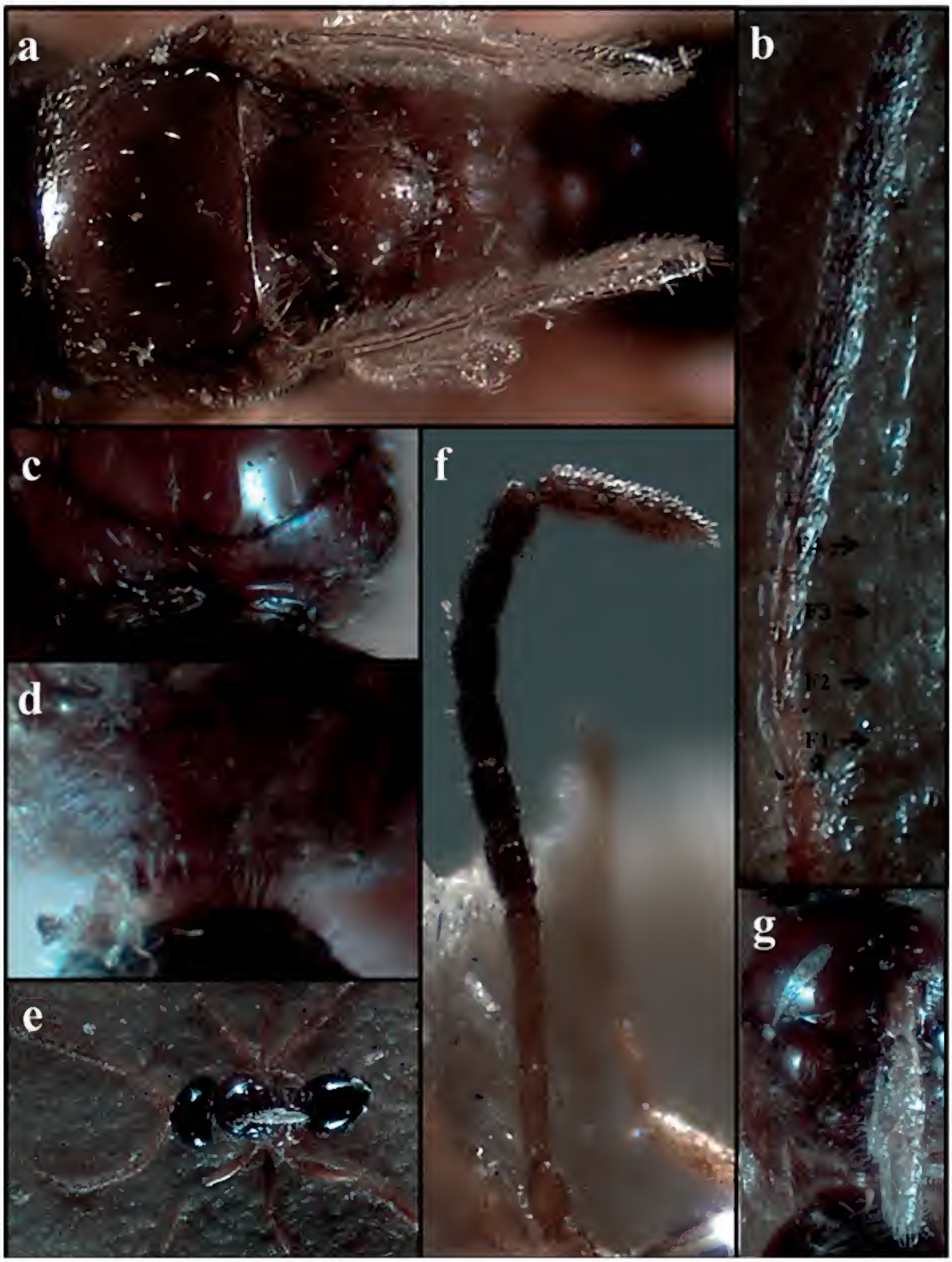

Figure 2. *Alloxysta pedestris* (Curtis, 1838): (a) mesoscutum female; (b) antenna male; (c) pronotum; (d) propodeum; (e) body male; (f) antenna female; (g) mesoscutum male.

Redescription

Colouration. Head and metasoma dark brown; mesosoma brown; scape yellowish brown; pedicel–F3 dark yellow, and F4–F12 brown; legs dark yellow.

Head. It cannot be seen.

Antenna. Female: 13-segmented, filiform; all antennomeres covered with sparse setae; F1–F3 thinner and smooth than remaining flagellomeres; F4–F11 with rhinaria and club shaped; antennal formula: 2.7 (1.8); 4.0 (1.1); 3.5 (1.1); 3.0 (1.1); 3.5(1.6) (fig. 2f). Male: 14-segmented, filiform; all antennomeres covered with sparse setae; F1–F3 thinner and smooth than remaining flagellomeres; F4–F12 with rhinaria and club shaped; antennal formula: 2.5 (2.0); 3.6 (1.1); 3.0 (1.2); 3.0 (1.2); 3.0 (1.5) (fig. 2b).

Mesosoma. Pronotum covered by few setae, almost absent on distolateral corners and in central area; without carinae present (fig. 2c); mesoscutum smooth and shiny, round in dorsal view with few scattered setae; scutellum also smooth and shiny with scattered setae, which are more abundant on apex of scutellum; height of mesopleural triangle along anterior margin 1.4 times height of mesopleuron; propodeum covered with setae, without carinae (fig. 2d).

Forewing. Shorter than body length, 2.8 times as short as mesosoma and metasoma together in both male and female (fig. 2a and g); covered with dense pubescence; marginal setae present; without radial cell.

Metasoma. Anterior part with an incomplete ring of setae, glabrous at centre, wider laterally; metasoma smooth and shiny, T3 and T4 clearly visibly distinguished.

Distribution. Palaearctic.

Comments. According to Quinlan and Fergusson (1981), *Alloxysta pedestris* (Curtis) is represented by three specimens in the Curtis collection (two males and one female). One male was designated by Quinlan and Fergusson (1981) as the lectotype because it corresponds more precisely with the original description; the female is considered to be a paralectotype; the other male cannot be a syntype because of the date. As a result of this, the type series of *Alloxysta pedestris* consists of just two specimens, lectotype male and paralectotype female, here studied.

Alloxysta victrix (Westwood, 1833)

(= *Cynips fulviceps* Curtis, 1838)

Combinations of *Cynips fulviceps* Curtis (Curtis, 1838, p. 688); *Allotria fulviceps* (Curtis) (Kieffer, 1900, p. 114); *Allotria* (*Allotria*) *fulviceps* (Curtis) (Dalla Torre and Kieffer, 1902, p. 41); *Charips* (*Charips*) *fulviceps* (Curtis) (Dalla Torre and Kieffer, 1910, p. 288); *Alloxysta fulviceps* (Curtis) (Fitton, 1978, p. 65); *Alloxysta victrix* (Westwood) (Pujade-Villar *et al.*, 2011, p. 68).

The study of *Alloxysta fulviceps* (Curtis) type material was recently treated in a previous paper (Pujade-Villar *et al.*, 2011). The type series consists of three specimens; Kerrich designated the holotype in 1948 without publishing it. Quinlan and Fergusson (1981) published Kerrich's conclusions. This specimen cannot be the holotype but must be the lectotype, according to Article 74.6 of the International Code of Zoological Nomenclature (ICZN, 1999), because Curtis did not mention the number of specimens used for its description. On the other hand, this specimen was considered lost according to Catriona McPhee (pers. comm., 21 Feb 2011). For this reason Pujade-Villar *et al.* (2011) designated a new lectotype for this species after thoroughly studying the original description by Curtis. In the same paper, *A. fulviceps* was considered to be a new synonym of *Alloxysta victrix* (Westwood, 1833).

However, after revising the Curtis collection the 'holotype' designated by Kerrich has been found. Due to several characters differing from Curtis's original description it cannot be considered a syntype of *Cynips fulviceps* and it is here rejected as such: (i) the mesosoma and metasoma are not dark as Curtis mentioned in his description, they are brown; (ii) the base of the antennae are not ochre, they are yellowish; (iii) the club shape and brown colour of antennae begin on F4, not at the base as Curtis mentioned in his description; (iv) F1 is much longer than F2, not merely 'scarcely longer' as Curtis described; (v) in Curtis's description, the shape of the radial cell is not mentioned, so the decision of choosing a specimen with closed or partially open radial cell is not decisive to design the lectotype. For all these reasons, and according to Article 74.2 of the International Code of Zoological Nomenclature (ICZN, 1999), this specimen loses its status as lectotype, and the true lectotype of *Cynips fulviceps* Curtis is the specimen designated by Pujade-Villar *et al.* (2011). So, this species is a synonym of *Alloxysta victrix*, as Pujade-Villar *et al.* (2011) proposed.

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Rectarcturidae Poore, 2001 rediagnosed with descriptions of new Australian genera and species (Isopoda: Valvifera)

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Abstract

Poore, G.C.B. 2013. Rectarcturidae Poore, 2001 rediagnosed with descriptions of new Australian genera and species (Isopoda: Valvifera). *Memoirs of Museum Victoria* 70: 17–36.

The family Rectarturidae is rediagnosed and three new genera and four new species from Australia added to the single genus of two species known from Argentina. The new genera are differentiated from each other and from *Rectarcturus* in overall sculptural patterns, the male pleopod 1 exopod, setation, shape and proportion of articles of pereopods 2 and 3, and length and proportion of articles of the antenna. The new genera are *Galathearcturus* gen. nov., *Nowrarcturus* gen. nov. and *Tasmarcturus* gen. nov., and the new species are: *Galathearcturus antoniae* sp. nov., *Nowrarcturus jamesi* sp. nov., *Tasmarcturus erinae* sp. nov. and *T. lewisi* sp. nov. *Arcturus simplicissimus* Whitelegge, 1904 is assigned to *Tasmarcturus*. The South American genus, *Rectarcturus*, is rediagnosed; its two species, *R. kophameli* and *R. tuberculatus*, appear in a key to all species of the family.

Keywords

Crustacea, Isopoda, Valvifera, Rectarcturidae, *Galathearcturus*, *Nowrarcturus*, *Rectarcturus*, *Tasmarcturus*, new genera, new species

Introduction

In a major revision of the Isopoda Valvifera (Poore, 2001) a clade of eight 'arcturoid' families was recognised, in which the body is more or less cylindrical ('idoteoid' families are flat), and pereopods 2–4 are usually differentiated from pereopods 5–7 and bear rows of long, paired setae. In the three largest arcturoid families, Arcturidae Dana, 1849, Antarcturidae Poore, 2001 and Austrarcturellidae Poore and Bardsley, 1992, the body is more or less flexed between pereonites 4 and 5, the anterior half held somewhat or quite erect facilitating filter feeding by the long paired setae on pereopods 2–4 (Wägele, 1987). Four of the remaining families have fewer species than these three and fall into one clade defined on the basis of having a 'straight' body, without the capability of flexion. This clade comprises the Rectarcturidae Poore, 2001, Xenarcturidae Sheppard, 1957, Pseudidotheidae Ohlin, 1901 and Arcturididae Poore, 2001, each with only one genus. In Rectarcturidae, pereopods 2–4 carry elongate setae as in the larger families; in Xenarcturidae, only pereopods 2 and 3 do; in Pseudidotheidae, pereopods 2–4 bear long robust setae; and Arcturididae have similar ambulatory pereopods 2–7 without long setae. The eighth family, Holidoteidae Wägele, 1989, with three genera (Poore, 2003), also appears to lack pereonal flexion but, at least in the cladogram published by Poore (2001: fig. 4), is sister family to Austrarcturellidae. This suggests that the straight body-form has been derived twice. Closer examination of the articulation between pereonites 4 and 5 suggests that not all of these taxa are as 'straight' as assumed, and all except Arcturididae can elevate anterior body segments off the substrate, at least slightly, while attaching using pereopods 5–7. No observations of these taxa alive have been reported.

This paper concentrates on one of these so-called straight families, Rectarcturidae. Whereas in the other families pleopod 1 of the male has the groove on the posterior face of the exopod ending on a tapering distolateral apical extension, in *Rectarcturus* the groove ends distolaterally on an apex separated from a free distal lamina by a notch. The autapomorphy of *Rectarcturus* in Poore's (2001) analysis is pereopods 2–4 each having a short dactylus bearing a longer, setiform unguis. Park and Wägele (1995) redescribed in detail the two species of *Rectarcturus*: *R. kophameli* (Ohlin, 1901) and *R. tuberculatus* Schultz, 1981, both from Argentina. Here, an enigmatically described species and four new species from the southeastern Australian shelf are described; these are significantly different from the South American species and from each other and warrant three new genera. Another species, ascribed to this genus, is discussed.

The material examined is lodged in Museum Victoria, Melbourne (NMV), the Australian Museum, Sydney (AM), the Museum of Tropical Queensland, Townsville (MTQ), the National Museum of Natural History, Washington (USNM), and the Zoological Museum, University of Copenhagen (ZMUC, now the Natural History Museum of Denmark).

Photographs (fig. 1) were made using a Leica M205C microscope with Leica Application Suite 3.8.0.

Rectarcturidae Poore, 2001

Rectarcturidae Poore, 2001: 227. – Poore, 2003: 1843.

Diagnosis. Body strongly vaulted; head and pereonite 1 fused; pereonite 4 of similar length to pereonite 3; all pleonites fused into pleotelson. Body variously tuberculate or spinose but never with a posterior dorsolateral pair of strong spines on pleotelson; pleotelson without dorsolateral ridges ending in mediodorsal posterior spine. Dorsal coxal plates 2–7 obsolete, bases of pereopods exposed. Mouthparts and pereopod 1 visible in lateral view. Eyes well developed. Antenna flagellum of 2 articles plus distal claw. Pereopod 1 a gnathopod, pereopods 2–4 elongated, differentiated from ambulatory pereopods 5–7. Pereopod 1 dactylus evenly curved along anterior margin, evenly tapering. Pereopods 2–4 with long setae along flexor margins of ischium–propodus (up to 9 pairs per article, well-spaced), with short dactylus, unguis longer and setiform. Pereopod 4 similar to pereopod 3. Pereopods of males without dense fur of fine setae. Oostegites 1–4 functional, supported by coxal lobes, oostegites 5 present as articulating discs or absent. Penes fused as a single penial plate, apically simple. Pleopod 1 peduncle more elongate than on other pleopods, with marginal setae on rami longer than peduncle; exopod of male thickened laterally, with groove on posterior face ending distolaterally on an apex separated from a free distomesial lamina by a notch. Pleopod 2 of male with appendix masculina as long as or longer than endopod, basally less than half width of endopod. Uropodal exopod tapering, with 2–3 stout distal setae.

Remarks. The family was erected for one genus, *Rectarcturus* Schultz, 1981, on the basis of a cladistic analysis of the Valvifera (Poore, 2001). The diagnosis given above differs from the original in some important features. Pereopods 2–4 are described as possessing up to nine pairs of well-spaced long setae per article along the flexor margins of the merus–propodus. These setae are more spaced and fewer than those on Arcturidae and Antarcturidae. It is now realised that oostegites 1–4 are supported by coxal lobes, and that a vestigial oostegite 5 is present as a lobe in three of the four genera. The structure of the male pleopod 1 exopod is better defined as above.

Species of the family are recognisable, and distinguished from arcturids, antarcturids and austrarcturellids, by their straight bodies and reduced setation of pereopods 2–4. The structure of the male pleopod 1 exopod separates rectarcturids from other 'straight' families—the groove ends in a distolateral lobe separated from a distomesial lamina by a deep notch (see Poore, 2001: fig. 3 for examples from other families). Monotypic Xenarcturidae is also straight but has a flat body and ambulatory pereopod 4. The only species of Arcturididae is straight and cylindrical, and all pereopods except the first are essentially ambulatory. Pseudidoteidae have almost raptorial pereopods 2–4 (Poore and Bardsley, 2004), and Holidoteidae have a uniquely structured male pleopod 1 exopod and uropodal rami (Poore, 2003). Schultz (1981) diagnosed his new genus as a member of Arcturidae, but none of the characters he chose is especially diagnostic except for 'body much straighter than in most arcturids'. Schultz (1981) included four species. One of these, *Microarcturus laevis* is now *Austroacturus laevis* (Kensley, 1975), a member of Holidoteidae. Park and Wägele (1995) noted that another, *Arcturus patagonicus* Ohlin, 1901, is clearly geniculate between pereonites 4 and 5, and has a pair of sharp submedian spines on the head. They placed it in *Neoarcturus*, which they thought of as similar to *Rectarcturus*; *Neoarcturus* and some of the species they listed are also in Holidoteidae, but not this one. It and others from their list are now placed in the antarcturid genus *Fissarcturus* Brandt, 1990 (Poore, 2003). Another, *Rectarcturus tatianae* Kussakin and Vasina, 1995, from 6000 m depth in the South Atlantic, is a geniculate species, so is not in this genus as presently defined. Its setiform unguis on pereopods 2–4, short antennal flagellum, male pleopod 2 structure, and paired body tuberculation suggest another species of *Fissarcturus*, but without the prominent posterior pleotelsonic spines.

The two species of *Rectarcturus* are from Argentina. Australian species that can be placed in the family are sufficiently different from *Rectarcturus* and diverse to warrant three new genera. They are diagnosed and four new species described here. The poorly described *Arcturus simplicissimus* Whitelegge, 1904 is allocated to one of the new genera on the basis of the description of a neotype.

The four genera are separated on the basis of differences in overall sculptural patterns, the male pleopod 1 exopod, setation, shape and proportion of the antenna and pereopods 2 and 3. The key uses the most conveniently observed characters; a key based on the structure of the male pleopod 1 exopod would lead to different dichotomies. Whereas in *Rectarcturus* and *Tasmarcturus* gen. nov. the groove on the posterior face of the male pleopod 1 exopod ends obliquely on a truncate distolateral lobe, not extending beyond the distomesial seta-bearing lamina, in *Nowrarcturus* gen. nov. it ends on a conical apical projection, extending beyond the lamina. The male of *Galathearcturus* gen. nov. is unknown, but its only species differs sculpturally from all others.

Key to genera and species of Rectarcturidae

1. Antenna less than twice dorsal length of (head + pereonite 1); article 4 subspherical, about as long as fused articles (1 + 2); article 5 at least twice as long as article 4; pereopod 2 (dactylus body + unguis) 3 times as long as propodus **2**

– Antenna at least 2.5 times dorsal length of (head + pereonite 1); article 4 cylindrical, at least twice as long as fused articles (1 + 2); article 5 shorter than or at most 1.5 times as long as article 4; pereopod 2 (dactylus body + unguis) shorter or at most 2.5 times as long as propodus **5**

2. Head with paired, submedian tubercles, pereonites with smooth, transverse ridges, anterior pleonites barely elevated; antenna article 3 cuboid, as long as deep, without ventrolateral flange (fig. 2) ..... ***Galathearcturus antoniae***

– Head, pereonites and anterior pereonites with paired blade-like submedian and sublateral tubercles/carinae, all secondarily tuberculate; antenna article 3 cuboid, as long as or little longer than deep, with ventrolateral teeth (fig. 1b–d) ..... ***Tasmarcturus*** **3**

3. Head ornamentation of strong acute tubercles separated in lateral view; submedian processes on pereonite 3 erect, digitiform, spinulose, especially in female, with prominent secondary process posteriorly (fig. 1d) ..... ***Tasmarcturus simplicissimus***

– Head ornamentation of flat tubercles almost contiguous in lateral view; submedian processes on pereonite 3 longitudinally flattened **4**

4. Head ornamentation rounded anteriorly in lateral view (fig. 1c) ..... ***Tasmarcturus lewisi***

– Head ornamentation prominently square anteriorly in lateral view (fig. 1b) ..... ***Tasmarcturus erinae***

5. Head with paired submedian tubercles, pereonites with smooth transverse ridges (pereonite 3 with second ridge anterior to major one), anterior pleonites barely elevated (fig. 1a) ..... ***Nowrarcturus jamesi***

– Head, pereonites and anterior pleonites with paired blade-like submedian and sublateral tubercles or carinae, smooth or barely secondarily ornamented ..... ***Rectarcturus*** **6**

6. Sculpture dominated by rows of submedian, sublateral, lateral and supracoxal longitudinal blades ..... ***Rectarcturus kophameli***

– Sculpture dominated by rows of submedian, sublateral, lateral and supracoxal longitudinal complex tubercles ..... ***Rectarcturus tuberculatus***

Galathearcturus gen. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:E79071AD-6121-4517-A9AB-A325E25456BA

Type species. Galathearcturus antoniae sp. nov., by monotypy and original designation.

Diagnosis. Head with paired submedian tubercles, pereonites with smooth transverse ridges, anterior pleonites barely elevated. Antenna 1.5 times dorsal length of (head + pereonite 1); article 3 cuboid, as long as deep, without ventrolateral flange; article 4 subspherical, about as long as fused articles (1 + 2); article 5 cylindrical, 2.4 times as long as article 4, 5 times as long as wide. Pereopod 2 propodus palm convex, denticulate; (dactylus body + unguis) 3 times as long as propodus; unguis setiform, as long as dactylus body. Pereopod 3 similar to pereopod 2, unguis shorter. Male pleopod 1 exopod unknown. Oostegites 5 a pair of adjacent oval discs.

Etymology. From *Galathea*, the ship and expedition that collected the type species, and *Arcturus*, generic stem.

Composition. Type species only.

Distribution. Southern Qld, Australia.

Remarks. The sole species of *Galathearcturus* shares a short antenna and long pereopod 2 dactylus with the three species of *Tasmarcturus*, but differs in dorsal sculpture; this species is the least sculptured of all rectarcturid genera. Unfortunately, the male is unknown.

Galathearcturus antoniae sp. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:C2E736F0-6E2D-4680-A446-C2DD94E8FA2D

Figures 2, 3

Material examined. Holotype. Australia, Qld, off Maroochydore (26°33'S, 153°31'E), 86 m, 5 Nov 1951 (*Galathea* stn 539), ZMUC (ovigerous female, 6.3 mm).

Description. Ovigerous female. Pereonites 2–4 swollen, taller and broader than more anterior and posterior segments, smooth between major sculptures, 2.6 times as long as greatest width. Pleotelson 0.3 times total body length.

Head with pair of submedian tubercles on anterior margin, pair of submedian, erect, obliquely transverse blades, followed by pair of submedian, sharp, erect ridges converging posteriorly and divided along their lengths by a shallow, dorsal notch; maxillipedal segment indistinguishable from cephalon; ventrolateral margin smooth, with deep fissure between head and pereonite 1. Pereonite 1 without sculpture; pereonite 2 with obsolete submedian and sublateral bosses; pereonites 3 and 4 with obsolete submedian bosses and prominent sublateral conical tubercles; pereonites 5–7 with sublateral rounded tubercles. Submedian and sublateral tubercles on pereonites 1 and 2 simple; submedian processes on pereonite 3 obsolete. Pereonites 1–7 + maxillipedal segment with supracoxal, rounded-triangular, slightly excavate plates on 2–4, weaker on 5–7. Pereonites without supplementary ridges. Pleonites 1–2 with pair of obsolete submedian ridges; pleonite 3 barely distinguished from pleonite 2; posterior pleotelson with broad sublateral domes, with rounded lateral wings; pleotelson tapering evenly to sharply rounded apex, tapered section 0.5 times as long as wide.

Antennule flagellum with 1 pair plus 1 aesthetascs, article 2 without aesthetascs. Antenna, fused articles (1 + 2) short, stout, with ventrolateral flange; article 5 2.4 times length of article 4; flagellum of 3 articles, 0.7 times length of peduncle article 5.

Pereopod 1 propodus twice as long as wide. Pereopod 2 tuberculate only along flexor margins; dactylus unguis as long as dactylus body. Pereopod 4 with triangular lobe on extensor margin of basis; dactylus body 1.5 times as long as propodus, dactylus unguis setiform, 0.3 times length of dactylus body. Pereopods 5–7 with 2 small tubercles on extensor margins of ischium–carpus. Pereopod 7 dactylus body 0.75 times as long as propodus, unguis stout, 0.3 times length of dactylus body.

Oostegites 1–4 supported by oval coxal plates; oostegites 5 a pair of adjacent oval discs.

Uropodal exopod 0.8 times length of endopod.

Etymology. For my granddaughter, Antonia Salter.

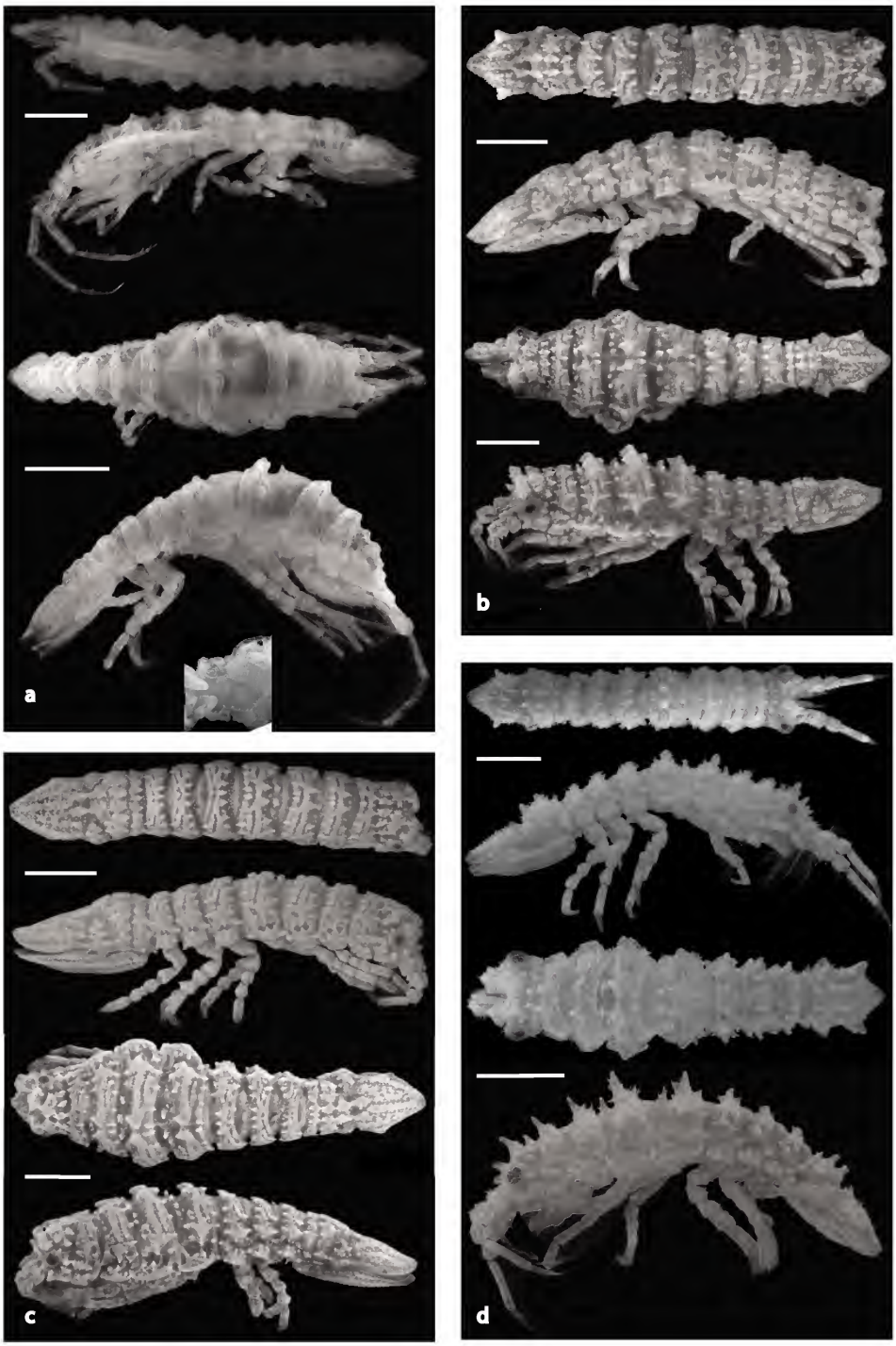

Figure 1. Dorsal and lateral views of four species of Rectarcturidae, males on top, females below. (a) *Nowrarcturus jamesi* sp. nov. (with ventral view of oostegites 3–5), male, NMV J19187; female, NMV J23734. (b) *Tasmarcturus erinae* sp. nov., male, NMV J16686; female, NMV J62082. (c) *Tasmarcturus lewisi* sp. nov., male and female, NMV J23743. (d) *Tasmarcturus simplicissimus* (Whitelegge, 1904), male and female, NMV J8758. Scale bars = 1 mm.

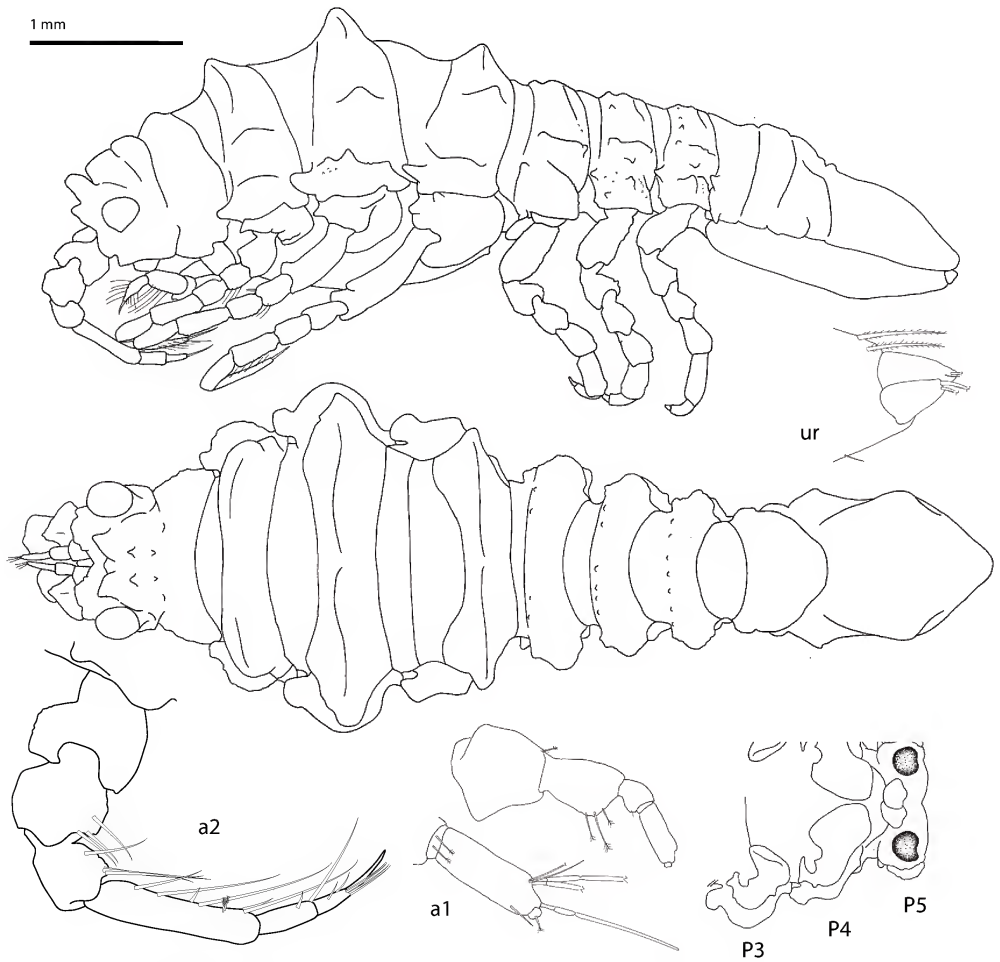

Figure 2. *Galathearcturus antoniae* sp. nov. Female holotype, ZMUC: habitus; a1, a2, antennule, antenna; ur, uropodal rami; P3–P5, oostegites and coxal plates of pereonites 3–5.

Distribution. Southern Qld, Australia, 26°S, 86 m depth.

Remarks. For similarities see notes for the genus. The only specimen is an ovigerous female; the male is unknown.

Nowrarcturus gen. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:6D11DFB5-917A-4D1C-8F2A-AAC9969DD029

Type species. Nowrarcturus jamesi sp. nov., by monotypy and original designation.

Diagnosis. Head with paired submedian tubercles, pereonites with smooth transverse ridges (third with second ridge anterior to major one), anterior pleonites barely elevated. Antenna 2.5 times dorsal length of (head + pereonite 1); article 3 cylindrical, twice as long as deep, without ventrolateral flange; article 4 cylindrical, more than twice as long as fused articles (1 + 2); article 5 cylindrical, 1.5 times as long as article 4, 5 times as long as wide. Pereopod 2 propodus palm convex, denticulate; (dactylus body + unguis) 2.5 times as long as propodus; unguis setiform, little longer than dactylus body. Pereopod 3 similar to pereopod 2, unguis shorter. Male pleopod 1 exopod groove ending obliquely on conical apical projection, extending beyond distomesial seta-bearing lamina. Male pleopod 1 endopod about three-quarters exopod length. Oostegites 5 a pair of adjacent oval discs.

Etymology. From Nowra, a town in NSW near to the type locality of the type species, and *Arcturus*, generic stem.

Composition. Type species only.

Distribution. Southern NSW, Australia.

Remarks. The sole species of *Nowrarcturus* is distinguished by

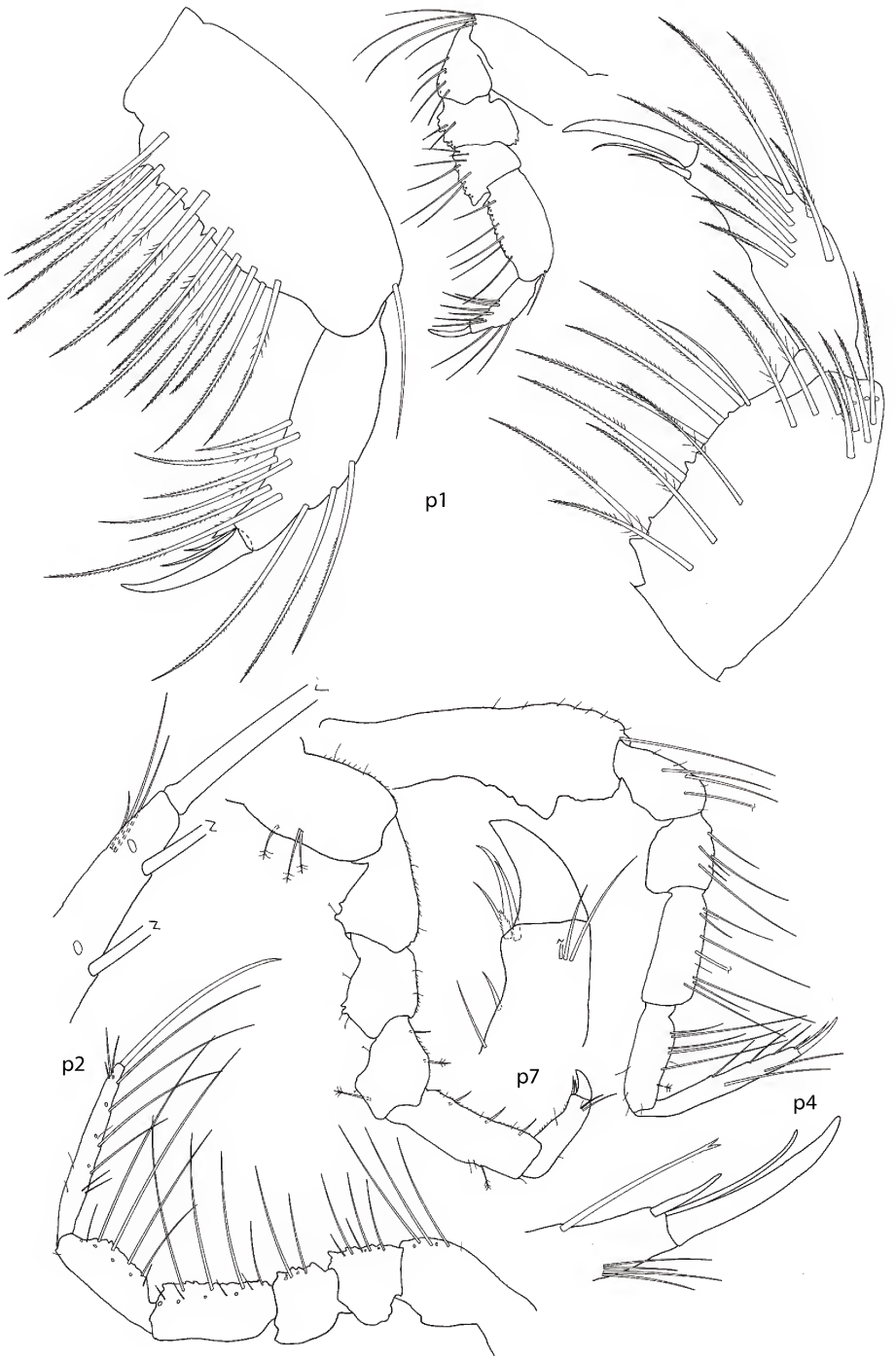

Figure 3. *Galathearcturus antoniae* sp. nov. Female holotype, ZMUC: p1, p2, p4, p7, pereopods 1, 2, 4 and 7, with details of distal articles.

smooth transverse ridges on pereonites 1–4 and the elongate articles of the antennal peduncle. The relationship between the two lobes of the major transverse ridge on pereonite 3 and the pair of smaller lobes opposing it anteriorly, especially evident in females, is unique. This genus is the only rectarcturid in which the groove on the exopod of the male pleopod 1 ends obliquely on a conical apical projection, extending beyond the distomesial seta-bearing lamina.

Nowrarcturus jamesi sp. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:1C749725-DF07-48BB-8B5A-7364487E1812

Figures 1a, 4–6

Material examined. Holotype. Australia, NSW, 54 km ESE of Nowra (34°52.7'S, 151°15.04'E), 990–996 m, 22 Oct 1988 (stn SLOPE 53), NMV J23444 (male, 6.3 mm).

Paratypes. Collected with holotype. NMV J23734 (ovigerous female, 6.5 mm); NMV J19188 (1 male, 2 females, 1 manca); J19747 (ovigerous female, 6.5 mm).

NSW, off Nowra (34°52.3'S, 151°15.0'E), 1096–1118 m, 15 Jul 1986 (stn SLOPE 7), NMV J19187 (male, 6.0 mm; female, 4.8 mm). (All collected by WHOI epibenthic sled by G.C.B. Poore et al., Museum Victoria.) E of Broken Bay (33°36'S, 152°09'E), 1097 m, 4 Dec 1979 (stn K79-20-07), AM P.32672 (male, 6.0 mm).

Description. Male. Of even dimensions throughout length, sparsely and microscopically pustulose between transverse ridges, 3.2 times as long as greatest width. Pleotelson 0.25 times total body length.

Head with 3 pairs of submedian dorsal blunt tubercles: first conical, second broader, third ridge-like, all simple; maxillipedal segment with simple transverse ridge; ventrolateral margin smooth, with anterior triangular projection. Pereonites 1–7 each with pair of submedian and pair of sublateral blunt tubercles on transverse ridge. Submedian and sublateral tubercles on pereonites 1 and 2 secondarily pustulose; submedian processes on pereonite 3 flat transversely, anteriorly curved, meeting as shallow notch. Pereonites 1–7 + maxillipedal segment with supracoxal tubercles, weaker on 5–7. Pereonites 3 and 4 with sharp, bilobed, middorsal, transverse, posteriorly sloped ridge anterior to main ridge (less well defined on 4). Pleonites 1 and 2 with obsolete lateral bosses; pleonite 3 domed middorsally, with rounded marginal lobes; posterior pleotelson evenly domed, with rounded lateral wings; pleotelson tapering evenly to sharply rounded apex, tapered section 0.7 times as long as wide.

Antennule flagellum article 1 with 3 pairs plus 1 aesthetascs, article 2 with 2 aesthetascs. Antenna, fused articles (1 + 2) short, stout, with ventrolateral flange; article 5 1.5 times length of article 4; flagellum of 3 articles, almost as long as peduncle article 5.

Pereopod 1 propodus 2.5 times as long as wide. Pereopod 2 tuberculate, especially basis and flexor margin of carpus; dactylus unguis 1.2 times length of dactylus body. Pereopod 4 dactylus body 1.4 times as long as propodus, unguis setiform, 0.5 times length of dactylus body. Pereopods 5–7 with several small tubercles on extensor margin of basis–carpus. Pereopod 7 dactylus body 0.6 times as long as propodus, unguis stout, 0.5 times length of dactylus body.

Male pleopod 1 exopod 4 times as long as basal width; posterior face with 2 longitudinal erect lobes parallel to groove; lateral margin bearing row of 8 long simple setae proximally, 11 short simple setae distally; distomesial seta-bearing lamina well separated from much longer apex by triangular notch.

Uropodal exopod 0.7 times length of endopod.

Ovigerous female. Pereonites 2–4 swollen, taller and broader than more anterior and posterior segments. Submedian processes on pereonite 3 flat transversely, anteriorly curved, overhanging, meeting as a deep notch, and opposing a pair of more anterior erect submedian tubercles. Oostegites 1–4 supported by oval coxal plates; oostegites 5 a pair of adjacent oval discs.

Distribution. Southern NSW, Australia, 34–42°S, 990–1118 m depth.

Etymology. For my grandson, James Salter.

Remarks. Females of the new species are immediately recognisable by the dorsal sculpture, particularly the characteristic submedian ridges and lobes on pereonite 3. This structure is less well developed in males.

Rectarcturus Schultz, 1981

Rectarcturus Schultz, 1981: 67–68. – Park and Wägele, 1995: 69–71.

Type species. Arcturus kophameli Ohlin, 1901, by original designation.

Diagnosis. Head, pereonites and anterior pereonites with paired blade-like submedian and sublateral tubercles or carinae, smooth or barely secondarily ornamented. Antenna 2.5–3 times dorsal length of (head + pereonite 1); article 3 cuboid, as long as deep, without ventrolateral flange; article 4 cylindrical, more than twice as long as fused articles (1 + 2); article 5 cylindrical, 0.7 times length of article 4, 5 times as long as wide. Pereopod 2 propodus palm straight, smooth; (dactylus body + unguis) as long as or little shorter than propodus; unguis setiform, little shorter than dactylus body. Pereopod 3 similar to pereopod 2, unguis shorter. Male pleopod 1 exopod groove ending obliquely on truncate distolateral lobe, not extending beyond distomesial seta-bearing lamina. Male pleopod 1 endopod about as long as exopod length. Oostegites 5 absent.

Composition. Rectarcturus kophameli (Ohlin, 1901), *R. tuberculatus* Schultz, 1981.

Distribution. Argentina.

Remarks. Rectarcturus comprises two Argentinian species differentiated from those in the three Australian genera. The genus is most similar to *Tasmarcturus* but lacks the strong secondary ornamentation of the principal pereonal tubercles, has a much longer article 4 on the antenna, has a straight palm on pereopod 1 (all other genera are denticulate), the dactylus and unguis of pereopod 2 are little if at all longer than the propodus (much longer in all other genera), its unguis is shorter than the dactylus body (as long as or longer in others), and oostegites 5 are absent.

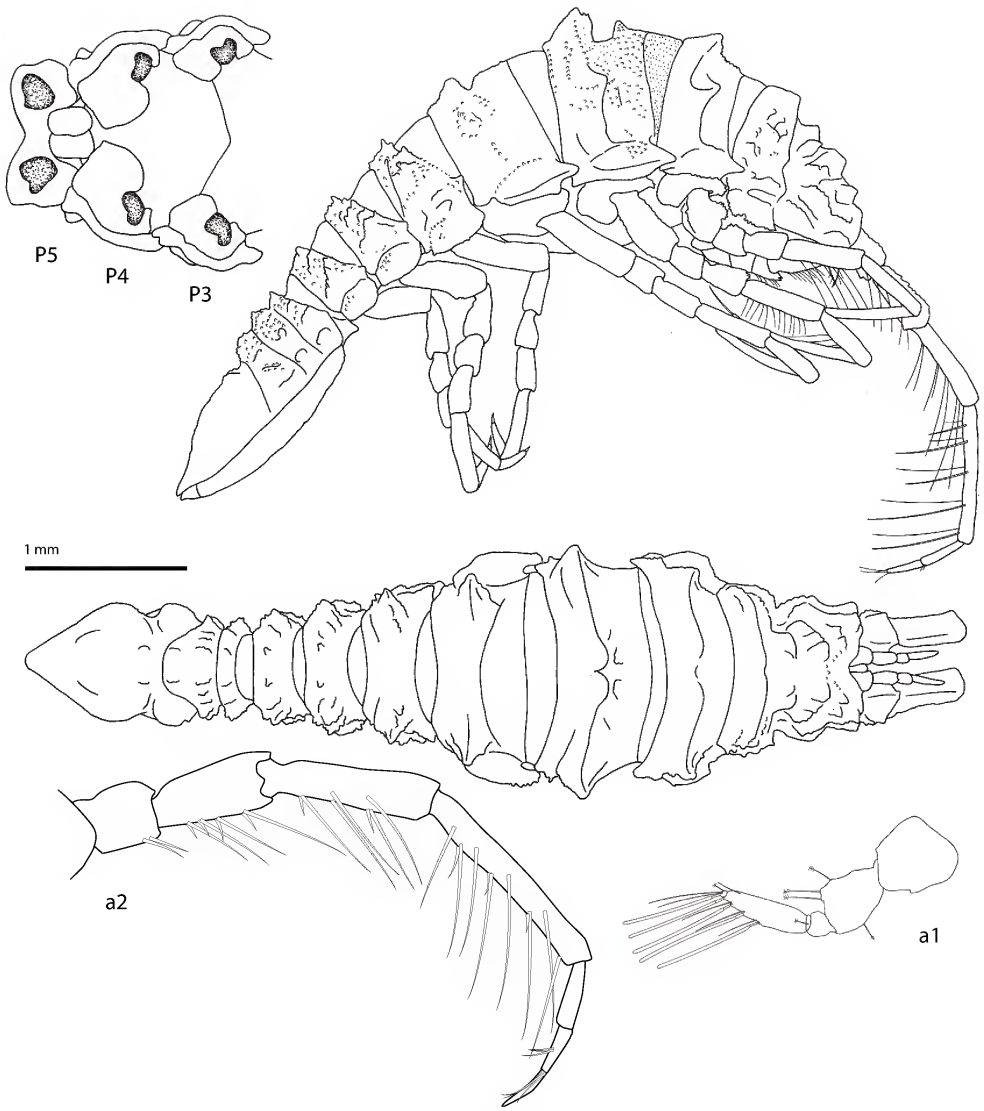

Figure 4. *Nowrarcturus jamesi* sp. nov. Female paratype, NMV J23734: habitus; P3–P5, oostegites and coxal plates of pereonites 3–5. Male holotype, NMV J23444: a1, antennule; a2, antenna.

Rectarcturus kophameli (Ohlin, 1901)

Arcturus kophameli Ohlin, 1901: 272–273, fig. 5.
Antarcturus kophameli. – Stebbing, 1908: 53.
Microarcturus kophameli. – Nordenstam, 1933: 128.
Rectarcturus kophameli. – Schultz, 1981: 68, fig. 3A–G. – Park and Wägele, 1995: 71–75, figs 9–12. – Poore, 2003: 1843.

Types. Northern Argentina, 38°S, 56°W, 52 fm [95 m] depth, holotype, female, 11 mm, lost.

Material examined. Argentina, Beagle Channel (55°S, 68°W, 63 m, Nov 1994, A. Brandt (*Victor Hansen* stn 1213), NMV J47040 (two specimens).

Description. Male. Pereonites 2–4 swollen, taller and broader than more anterior and posterior segments, sparsely and microscopically pustulose between transverse ridges, 3 times as long as greatest width. Pleotelson 0.3 times total body length. Head with 2 pairs of broad, blunt submedian tubercles, followed by single medial tubercle.

Antennule flagellum article 1 with 3 pairs plus 1 aesthetascs, article 2 with 2 aesthetascs. Antenna, fused articles (1 + 2) short, stout, with ventrolateral flange; article 5 0.5 times length of article 4; flagellum of 3 articles, 0.7 times length of peduncle article 5.

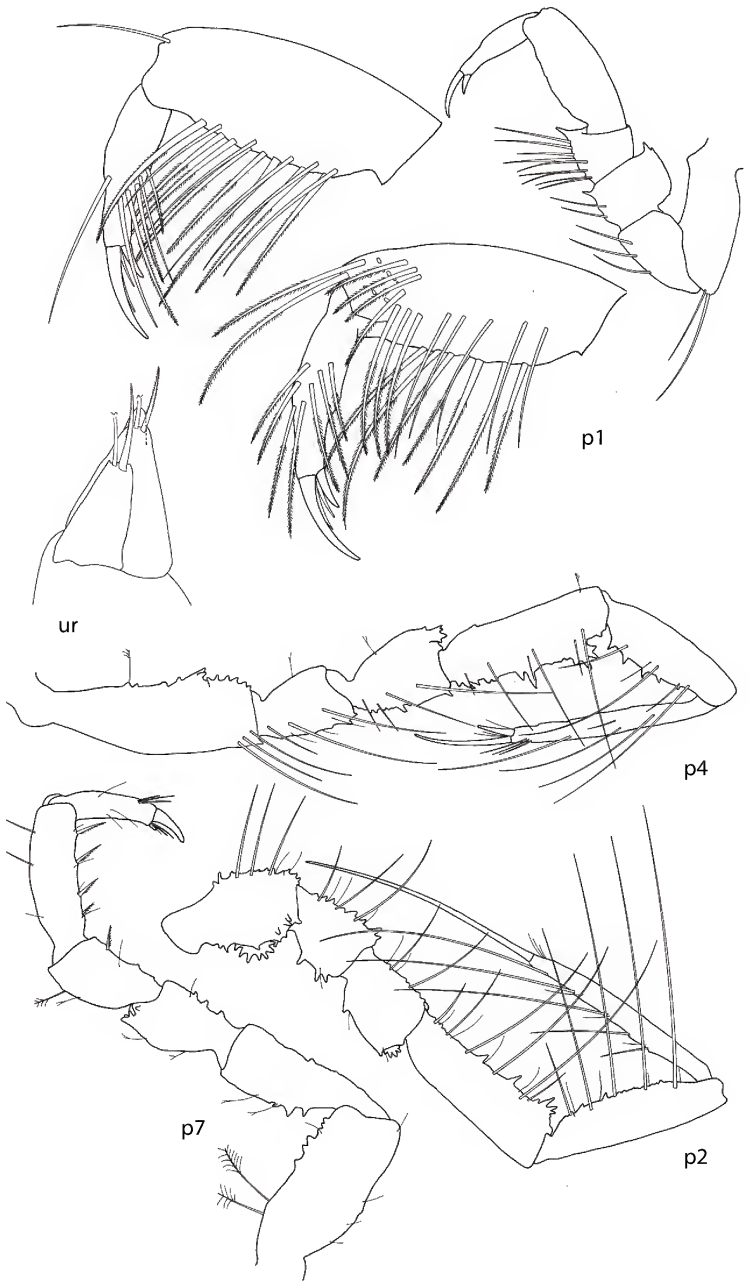

Figure 5. *Nowrarcturus jamesi* sp. nov. Male holotype, NMV J23444: p1, p2, p4, p7, pereopod 1 with details of distal articles, pereopods 2, 4 and 7; ur, uropodal rami.

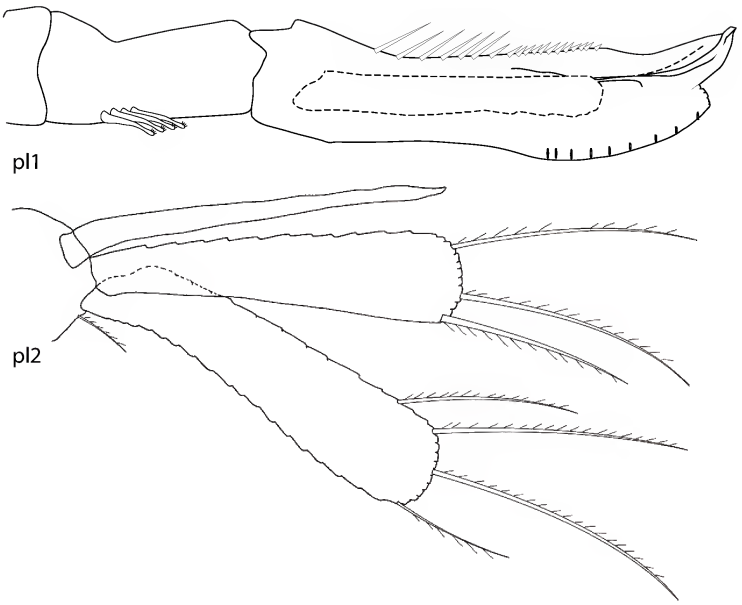

Figure 6. *Nowrarcturus jamesi* sp. nov. Male holotype, NMV J23444: pl1, pl2, pleopods 1, 2.

Pereopod 1 propodus 1.9 times as long as wide. Pereopod 2 with tubercle on extensor margin of basis only; dactylus unguis 0.9 times length of dactylus body. Pereopod 4 dactylus body 0.9 times as long as propodus, unguis setiform, 0.4 times length of dactylus body. Pereopods 5–7 without tubercles on extensor margin. Pereopod 7 dactylus body 0.7 times as long as propodus, unguis stout, 0.4 times length of dactylus body.

Male pleopod 1 exopod more than 4 times as long as basal width; posterior face without erect lobes along groove; distomesial seta-bearing lamina well separated from apex by deep triangular notch and equalling it in length.

Uropodal exopod 0.5 times length of endopod.

Ovigerous female. See detailed description by Park and Wägele (1995). Oostegites 5 absent.

Distribution. Northern Argentina, 38°S, 95 m (type locality); Straits of Magellan, Argentina, 52°S, 10–12 m depth.

Remarks. Ohlin (1901) based his new species on an ovigerous female from off northern Argentina at 95 m depth. Schultz (1981) selected this as the type species of his new genus and redescribed it on the basis of new material, ovigerous females from off Isla de los Estados, southern Argentina, at 84–208 m depth. The holotype appears lost; it could not be found in the major museums in Stockholm, Hamburg or Berlin. Other authors transferred the species to other genera, *Antarcturus* and the *nomen nudum*, *Microarcturus*. The species is characterised by sharp submedian, sublateral and lateral longitudinal ridges on each pereonite, and sublateral ridges on pleonites 1 and 2. The lateral mid-length pleotelson marginal wings are weak. Ohlin commented on the 'very small hairs' over the whole body. Park and Wägele (1995) redescribed new material, taken at shallower depths in the Straits of Magellan, Argentina than the type locality. Their observations were confirmed by additional material from the same region (representatives of a larger collection at the Zoological Museum, Hamburg). W. Wägele (pers. comm.) observed the absence of oostegites 5 on the female described by Park and Wägele (1995) and now at Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.

Rectarcturus tuberculatus Schultz, 1981

Rectarcturus tuberculatus Schultz, 1981: 68–70, fig. 4. – Park and Wägele 1995: 75–83, figs 13–18.

Material examined. N of South Shetland Is., 57°09'S, 58°58'W – 58°00'S, 58°50'W, 3477–3590 m (*Eltanin* stn 6-363), USNM 181263 (ovigerous female, 9.5 mm).

Description. Antennule flagellum article 1 with 3 pairs plus 1 aesthetascs, article 2 with 2 aesthetascs. Antenna, articles 1–2 short, stout, with ventrolateral flange; article 5 0.7 times length of article 4; flagellum of 3 articles, 0.7 times length of peduncle article 5.

Pereopod 1 propodus twice as long as wide. Pereopod 2 with tubercle on extensor margin of basis only; dactylus unguis 0.9 times length of dactylus body. Pereopod 4 dactylus body 0.9 times as long as propodus, unguis setiform, 0.4 times length of dactylus body. Pereopods 5–7 with 2 stout tubercles on extensor margin of basis, 1 each on carpus–propodus.

Distribution. South Atlantic. N of South Shetland Is., 57–59°S, 3477–3590 m depth (type locality); Straits of Magellan, Argentina, 52°S, 25–41 m.

Remarks. Schultz's (1981) illustration shows pairs of submedian tubercles and several pairs of sublateral tubercles in transverse rows across each pereonite. The pleotelson has midlength lateral marginal wings. I have re-examined his type material at the US National Museum and can add to his brief description: pereopods 2–4 with well-spaced setae as in his figure, oostegites 1–4 with coxal supports, oostegites 5 absent. The species' type locality is at a greater depth than any other in the family, although Park and Wägele's record was at typical depths. Subtle differences between their extensive description and detailed illustrations and those of Schultz may indicate that they had material of another species: the propodi of pereopods 1 and 2 are less elongate than in the type, and the sculpture is more complex.

Tasmarcturus gen. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:9F13AC3F-F744-45E2-8868-6E34EFB34072

Type species. Tasmarcturus lewisi sp. nov., by original designation.

Diagnosis. Head, pereonites and anterior pereonites with paired blade-like submedian and sublateral tubercles or carinae, all secondarily tuberculate. Antenna 1.7–2 times dorsal length of (head + pereonite 1); article 3 cuboid, as long as or little longer than deep, with ventrolateral teeth; article 4 subspherical, about as long as fused articles (1 + 2); article 5 cylindrical, 2–2.5 times as long as article 4, 5 times as long as wide. Pereopod 2 propodus palm convex, denticulate; (dactylus body + unguis) 3 times as long as propodus; unguis setiform, as long as or little longer than dactylus body. Pereopod 3 similar to pereopod 2, unguis shorter. Male pleopod 1 exopod groove ending obliquely on truncate distolateral lobe, not extending beyond distomesial seta-bearing lamina. Male pleopod 1 endopod about as long as exopod length. Oostegites 5 a pair of adjacent oval discs.

Etymology. For Abel Tasman (1603–1659), the first European to reach the Australian state, Tasmania, and *Arcturus*, generic stem.

Composition. *Tasmarcturus erinae* sp. nov., *T. jamesi* sp. nov., *T. simplicissimus* (Whitelegge, 1904).

Distribution. Southern Qld to Bass Strait, eastern Australia.

Remarks. *Tasmarcturus* comprises three Australian species, two new and one described as a species of *Arcturus* in 1904. All are common on the southeastern Australian shelf. The genus shares with *Galathearcturus* a compact antenna and elongate dactylus with setiform unguis on pereopods 2–4, but differs in having far more elaborate dorsal sculpture. The termination of the exopodal groove on the male pleopod 1 is similar to that in *Rectarcturus*; the structure is unknown in *Galathearcturus*. Sculpture can be used to differentiate the three species.

Tasmarcturus erinae sp. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:2792F44A-A83F-42A3-AFFA-1D5E6DBABC8C

Figures 1b, 7, 8

Material examined. Holotype. Australia, Tas., E of Maria I (42°36'S, 148°10'E), 75 m, 23 Apr 1985 (stn TAS-30), NMV J16686 (male, 6.3 mm).

Paratypes. Collected with holotype, NMV J62082 (ovigerous female, 7.1 mm); NMV J8766 (2 mancas, 2.6 mm; ovigerous female, 7.0 mm).

Tasmania, 5 km NE of Mistaken Cape (42°37.0'S, 148°12.3'E), 100 m, 23 Apr 1985 (stn TAS-31), NMV J16685 (2 males). 15 km E of Maria I (42°37'S, 148°20'E), 102 m, 9 Oct 1984 (stn BSS-221), NMV J16681 (manca); NMV J23446 (2 mancas, 5 males, 1 ovigerous female). Eastern Bass Strait, 100 km NE of North Point, Flinders I (38°52.36'S, 148°25.12'E), 140 m, 15 Nov 1981 (stn BSS-170), NMV J23447 (12 mancas, 7 males, 1 female).

Description. Ovigerous female. Pereonites 2–4 swollen, taller and broader than more anterior and posterior segments, with highly spinulose transverse ridges and numerous spinules besides, 3.1 times as long as greatest width. Pleotelson 0.3 times total body length.

Head ornamentation prominently square anteriorly in lateral view, comprising high suprantennal forehead, frontal margin ornamented with pair of transverse ridge-like tubercles, with pair of oblique–transverse ridges separated by medial V-shaped notch, followed by pair of less prominent submedian oblique–longitudinal blade-like ridges, all microtuberculate; maxillipedal segment with double transverse ridge with 2 or 3 pairs of spinules front and back; ventrolateral margin with anterior triangular lobe in front of eye, and deep fissure between head and pereonite 1. Pereonite 1 with transverse ridge (doubled laterally) bearing pairs of anterior and posterior spinules ranging from submedian to sublateral; pereonite 2 with pair of submedian blunt, hatchet-like projections, with transverse ridge (doubled laterally) bearing pairs of anterior and posterior spinules concentrated on sublateral swellings, plus submedian posterior tubercles; pereonites 3 and 4 similar to pereonite 2, pereonite 3 with the most prominent ornamentation, a ridge ending laterally as a sharp projection; pereonites 5–7 each with double transverse ridge bearing 4 pairs of anterior spines and 2 pairs of posterior spines. Submedian and sublateral tubercles on pereonites 1 and 2 secondarily pustulose; submedian processes on pereonite 3 longitudinally flattened. Pereonites 1–7 + maxillipedal segment with supracoxal rounded plates, larger on 3 and 4, weaker on 5–7, all spinulose especially on dorsal surfaces, arranged such that a deep lateral groove exists between end of lateral ridge and supracoxal plate. Pereonites 2–4 each with transverse row of tubercles in front of main ridge, most complex on 3. Pleonites 1 and 2 with 4 pairs of tubercles, the submedian pair larger; pleonite 3 with submedian pair of tubercles, more prominent than on pleonites 1 and 2, and triangular lateral lobes; posterior pleotelson with anterior pair of submedian ridges and a posterior medial ridge, plus sublateral wing-like projections, with 2 pairs of lateral wings, anterior blade-like, posterior triangular; pleotelson tapering evenly to sharply rounded apex, tapered section 0.5 times as long as wide.

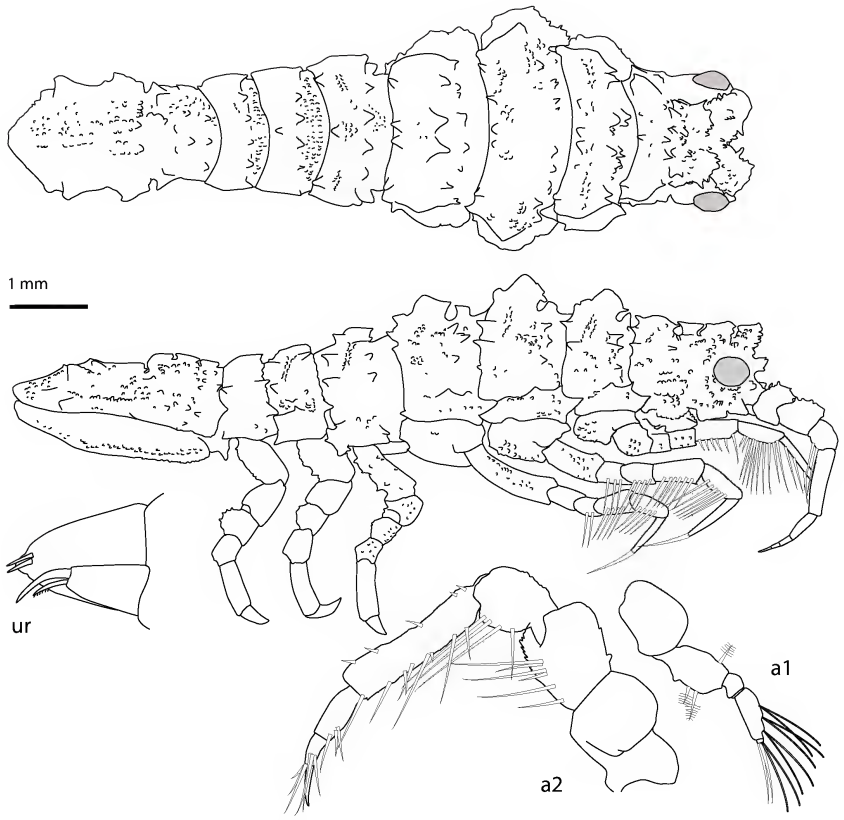

Figure 7. *Tasmarcturus erinae* sp. nov. Female paratype, NMV J62082: habitus; a1, antennule; a2, antenna; ur, uropodal rami.

Antennule flagellum article 1 with 4 pairs of aesthetascs, article 2 with 2 aesthetascs. Antenna, fused articles (1 + 2) short, stout, with ventrolateral flange; article 5 2.3 times as long as article 4; flagellum of 3 articles, 0.7 times length of peduncle article 5.

Pereopod 1 propodus 2.2 times as long as wide. Pereopod 2 tuberculate, especially basis and flexor margin of carpus; dactylus unguis as long as dactylus body. Pereopod 4 dactylus body 1.5 times as long as propodus, unguis setiform, 0.4 times length of dactylus body. Pereopods 5–7 with 2 to several tubercles on extensor margin of basis and ischium, 1 each on carpus and propodus. Pereopod 7 dactylus body 0.6 times as long as propodus, unguis stout, 0.4 times length of dactylus body.

Oostegites 1–4 supported by oval coxal plates; oostegites 5 a pair of adjacent oval discs.

Uropodal exopod 0.6 times length of endopod.

Male. Of even dimensions throughout length, with highly spinulose transverse ridges and numerous spinules besides. Head ornamentation prominently square anteriorly in lateral view, comprising frontal pair of submedian tubercles, followed by pair of prominent, erect, conical sublateral tubercles sitting over eyes but not obscuring in dorsal view, then pair of sublateral stellate tubercles; maxillipedal segment with 3 pairs of tubercles, all microtuberculate and together forming submedian ridges diverging and sloping upwards anteriorly; ventrolateral margin with anterior triangular lobe in front of eye, and deep fissure between head and pereonite 1. Pereonite 1 with transverse ridge (doubled laterally) bearing 1 medial and 4 pairs of spinules anteriorly and posteriorly, ranging from submedian to sublateral; pereonites 2–4 similar to pereonite 1 except medial spinules absent; pereonites 5–7 each with a single transverse ridge bearing 4 pairs of anterior spines and 2 pairs of posterior spines. Submedian and sublateral tubercles on pereonites 1 and 2 secondarily pustulose. Pereonites 1–7 + maxillipedal segment with supracoxal rounded plates, larger on 3 and 4, weaker on 5–7, all spinulose, especially on dorsal surfaces, arranged such that a deep lateral groove exists between end of lateral ridge and supracoxal plate. Pereonites 3 and 4 each with pair of submedian tubercles anterior to main ridge (larger on 4). Pleonites 1 and 2 with pair of obsolete submedian ridges; pleonite 3 similar to pleonite 2; posterior pleotelson with oblique–conical sublateral projections at midlength, with marginal boss posterior to this, with triangular lateral wings; pleotelson tapering evenly to sharply rounded apex, tapered section 0.6 times as long as wide.

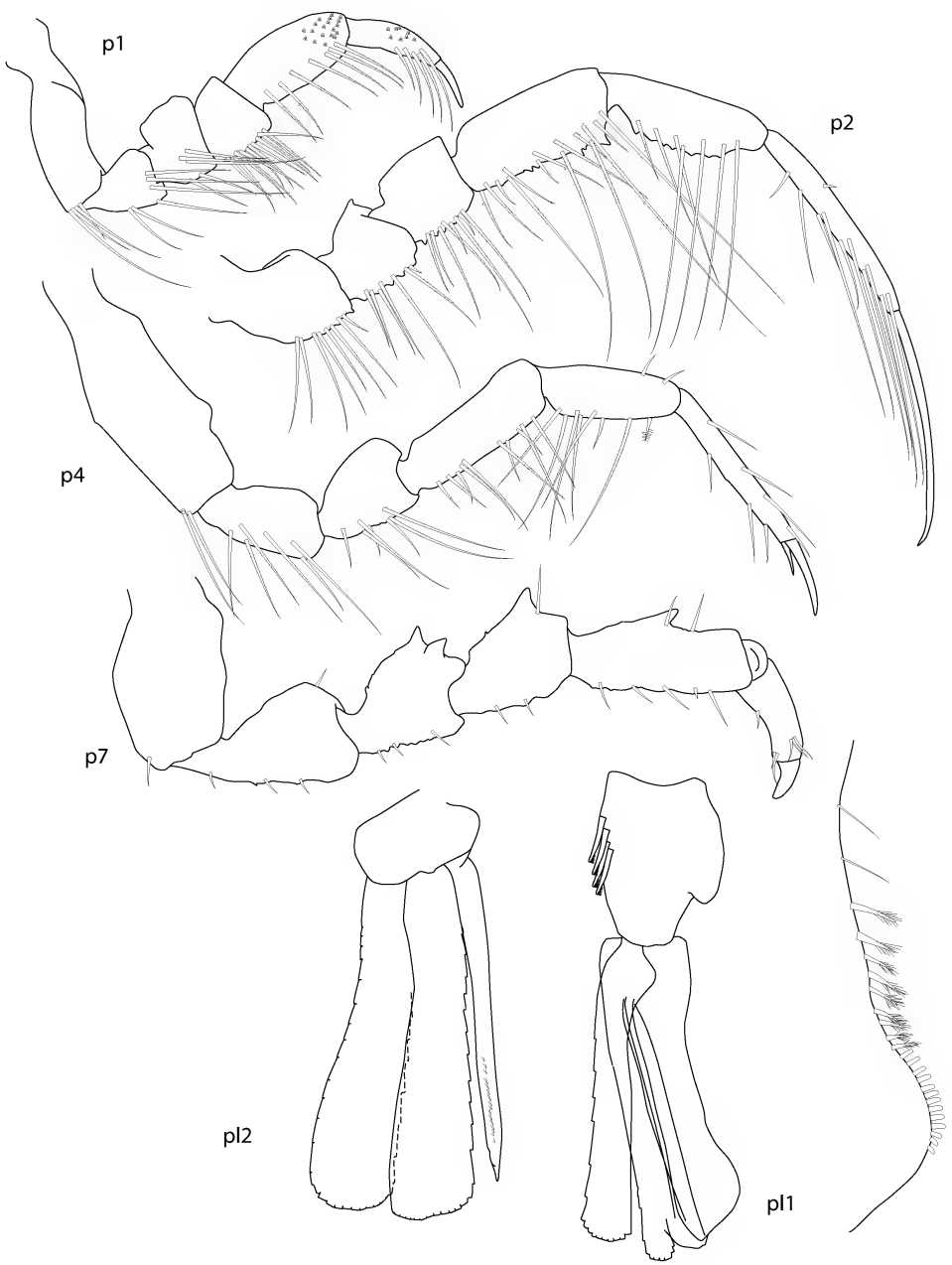

Figure 8. *Tasmarcturus erinae* sp. nov. Male holotype, NMV J16686: p1, p2, p4, p7, pereopods 1, 2, 4 and 7; pl1, pleopod 1 with detail of lateral margin; pl2, pleopod 2.

Male pleopod 1 exopod little more than 3 times basal width; exopod posterior face without erect lobes along groove; lateral margin bearing row of 6 multifid setae proximally, 9 stout setae distally; distomesial seta-bearing lamina well separated from apex by deep triangular notch and equalling it in length.

Etymology. For my granddaughter, Erin Poore.

Distribution. Southeastern Australia, 39–42.5°S, 75–102 m depth.

Remarks. Tasmarcturus erinae and *T. lewisi* are similar but differentiated most easily on the lateral profile of the head; the head has a pair of prominent anterodorsal projections in *T. erinae*. Neither species has the conical tubercles evident in *T. simplicissimus*.

Tasmarcturus lewisi sp. nov.

Zoobank LSID. http://zoobank.org/urn:lsid:zoobank.org:act:F3C16B94-1D11-4CC3-8A87-2FF8BA2B2004

Figures 1c, 9, 10

Rectarcturus sp. – Poore, 2001: fig 1e.

Material examined. Holotype. Australia, Tas., eastern Bass Strait, 25 km NE of Deal I (39°14.48'S, 147°31.30'E), 57 m, 18 Nov 1981 (stn BSS 174), NMV J23745 (male, 6.1 mm).

Paratypes. Collected with holotype, NMV J8768 (9 specimens).

Vic., eastern Bass Strait, 50 km SE of Port Albert (38°54.18'S, 147°13.24'E), 58 m, 18 Nov 1981 (stn BSS 176), NMV J23445 (female, 7.0 mm); NMV J23448 (male, 6.1 mm); NMV J23742 (male, 5.1 mm); NMV J23743 (ovigerous female, 6.6 mm); NMV J8781 (male, 4.3 mm); NMV J8780 (manca, 2.9 mm; 7 males, 4.5–6.0 mm; 4 females, 5.9–7.4 mm).

Other material. Tas., Vic. c. 58 specimens from eastern Tas., throughout Bass Strait, 38–42°S, 143–148°E, 26–140 m depth (see Museum Victoria database http://collections.museumvictoria.com.au/ for details). (All collected by WHOI epibenthic sled or SM grab by G.C.B. Poore et al., Museum Victoria.)

NSW, S of Worang Point, Twofold Bay (37°03.5'S, 149°56.5'E), 6 m, AM P.36070 (male).

Description. Ovigerous female. Pereonites 2–4 swollen, taller and broader than more anterior and posterior segments, with highly spinulose transverse ridges and numerous spinules besides, 2.7 times as long as greatest width. Pleotelson 0.3 times total body length.

Head ornamentation rounded anteriorly in lateral view, comprising pair of transverse submedian ridges on anterior margin, followed by pair of larger transverse ridges, spinulose anteriorly and posteriorly, reaching eyes laterally, then another similar thicker pair flattened dorsally; maxillipedal segment with 5 pairs of spinulose tubercles evenly spaced between submedian and sublateral positions; ventrolateral margin smooth, with deep fissure between head and pereonite 1. Pereonite 1 with transverse ridge (doubled laterally) bearing 2 medial tubercles (anterior and posterior) plus 5 pairs of more or less similarly arranged anterior and posterior spinules ranging from submedian to sublateral; pereonite 2 with transverse ridge (doubled laterally) bearing pair of submedian, anteriorly directed, flat, triangular projections decorated with spinules, anterior margin of ridge with 3 pairs of sublateral spines, posterior margin with 5 pairs of spinules, 1 lateral spine at end of ridge; pereonite 3 similar to pereonite 2, submedian decoration larger; pereonite 4 similar to pereonite 3, submedian and sublateral pairs of complex spines more developed; pereonites 5–7 each with transverse ridge bearing median, anteriorly directed spinule plus 4 pairs of anterior and 2 pairs of posterior spinules forming prominent sublateral complexes. Submedian and sublateral tubercles on pereonites 1 and 2 secondarily pustulose; submedian processes on pereonite 3 longitudinally flattened. Pereonites 1–7 + maxillipedal segment with supracoxal rounded plates, larger on 3 and 4, weaker on 5–7, all spinulose (especially on dorsal surfaces), arranged such that a deep lateral groove exists between end of lateral ridge and supracoxal plate. Pereonites 2–4 each with transverse row of tubercles in front of main ridge, most complex on 3. Pleonites 1 and 2 spinulose, developed into submedian plates on pleonite 2; pleonite 3 with submedian plates similar to pleonite 2, without sublateral spinules; posterior pleotelson with spinules arranged into a pair of flat submedian ridges and sublateral clusters, with rounded lateral wings; pleotelson tapering evenly to sharply rounded apex, tapered section 0.7 times as long as wide.

Antennule flagellum article 1 with 3 pairs plus 1 aesthetascs, article 2 with 2 aesthetascs. Antenna, fused articles (1 + 2) short, stout, with ventrolateral flange.

Pereopod 1 propodus twice as long as wide. Pereopod 2 tuberculate, especially basis and flexor margin of carpus; dactylus unguis as long as dactylus body. Pereopod 4 and extensor margin of basis; dactylus body 1.2 times as long as propodus, unguis setiform, 0.4 times length of dactylus body. Pereopods 5–7 with 2 to several tubercles on extensor margin of basis and ischium, 1 each on carpus and propodus. Pereopod 7 dactylus body 0.6 times as long as propodus, unguis stout, 0.5 times length of dactylus body.

Oostegites 1–4 supported by oval coxal plates; oostegites 5 a pair of adjacent oval discs.

Uropodal exopod 0.7 times length of endopod.

Male. Of even dimensions throughout length, with highly spinulose, transverse ridges and numerous spinules besides. Head ornamentation rounded anteriorly in lateral view, comprising high suprantennal forehead, frontal margin ornamented with 3 pairs of ridge-like tubercles, with pair of anterior transverse ridges separated by medial notch, almost occluded dorsally, followed by pair of submedian flattened ridges, all microtuberculate; maxillipedal segment with 5 pairs of spinulose tubercles evenly spaced between submedian and sublateral positions; ventrolateral margin smooth, with deep fissure between head and pereonite 1. Pereonite 1 with transverse ridge (doubled laterally) bearing 2 medial tubercles (anterior and posterior) plus 4 pairs of more or less similarly arranged anterior and posterior spinules ranging from submedian to sublateral; pereonite 2 with transverse ridge (doubled laterally) bearing 4 pairs of anterior and 4 pairs of posterior tubercles, irregularly spaced; pereonites 3 and 4 similar to pereonite 2; pereonites 5–7 each with a transverse ridge bearing a median, anteriorly directed spinule plus 5

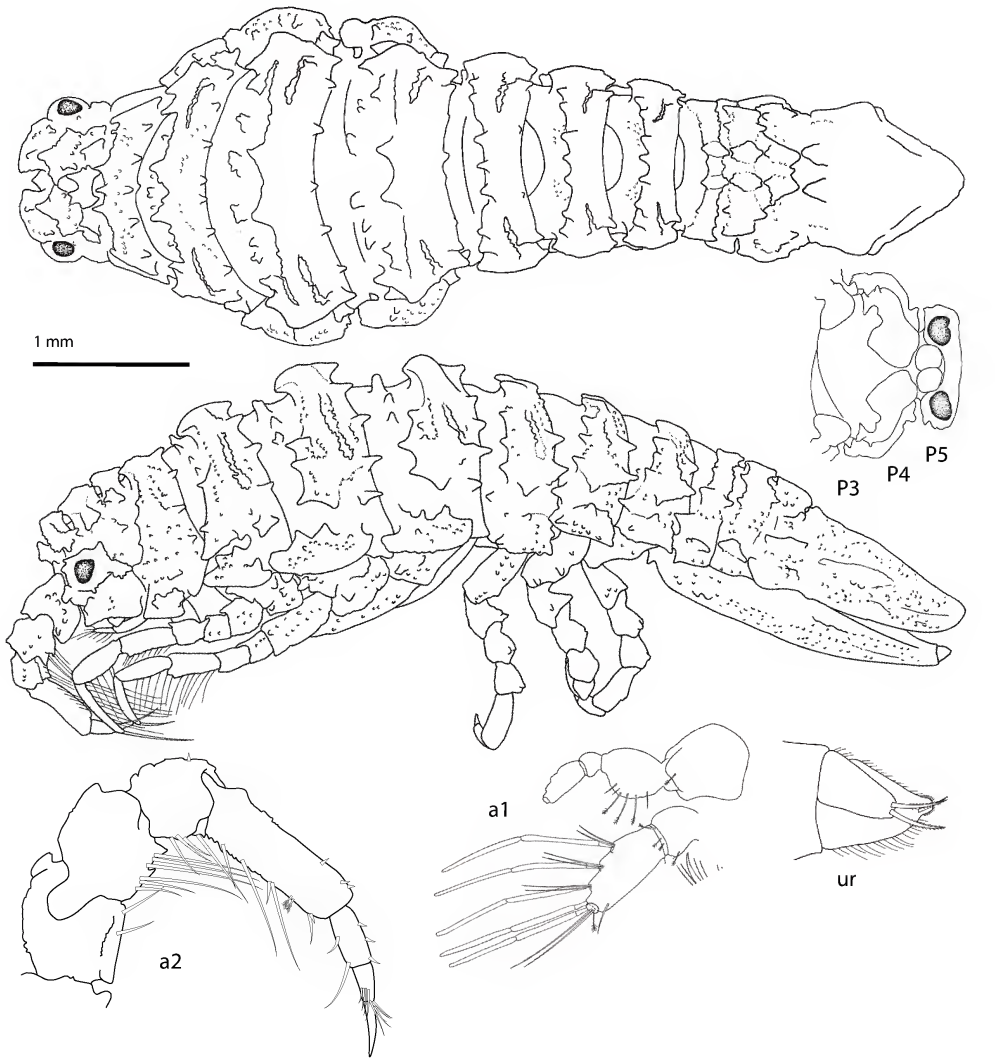

Figure 9. *Tasmarcturus lewisi* sp. nov. Female paratype, NMV J23743: habitus; P3–P5, oostegites and coxal plates of pereonites 3–5. Male holotype, NMV J23745: a1, antennule with detail of flagellum; a2, antenna; ur, uropodal rami.

pairs of anterior and 2 pairs of posterior spinules; submedian and sublateral tubercles on pereonites 1 and 2 secondarily pustulose; pereonites 1–7 + maxillipedal segment with supracoxal rounded plates, larger on 3 and 4, weaker on 5–7, all spinulose especially on dorsal surfaces, arranged such that a deep lateral groove exists between end of lateral ridge and supracoxal plate; pereonites 2–4 each with a transverse row of tubercles in front of main ridge, most complex on 3. Pleonites 1 and 2 with paired flat ridges divided into 1 medial and 2 sublateral plates on pleonite 1, and a pair each of flat submedian tubercles and sublateral tubercles; pleonite 3 with submedian plates similar to pleonite 2, without sublateral spinules; posterior pleotelson with spinules arranged into a pair of flat submedian ridges and sublateral clusters, with rounded lateral wings; pleotelson tapering evenly to a sharply rounded apex, tapered section 0.7 times as long as wide.

Antenna, article 5 twice as long as article 4; flagellum of 3 articles, 0.7 times length of peduncle article 5.

Male pleopod 1 exopod little more than 3 times basal width; posterior face without erect lobes along groove; lateral margin bearing row of 6 multifid setae proximally, 9 stout setae distally; distomesial seta-bearing lamina well separated from apex by deep triangular notch and well exceeding it in length.

Etymology. For my grandson, Lewis Poore.

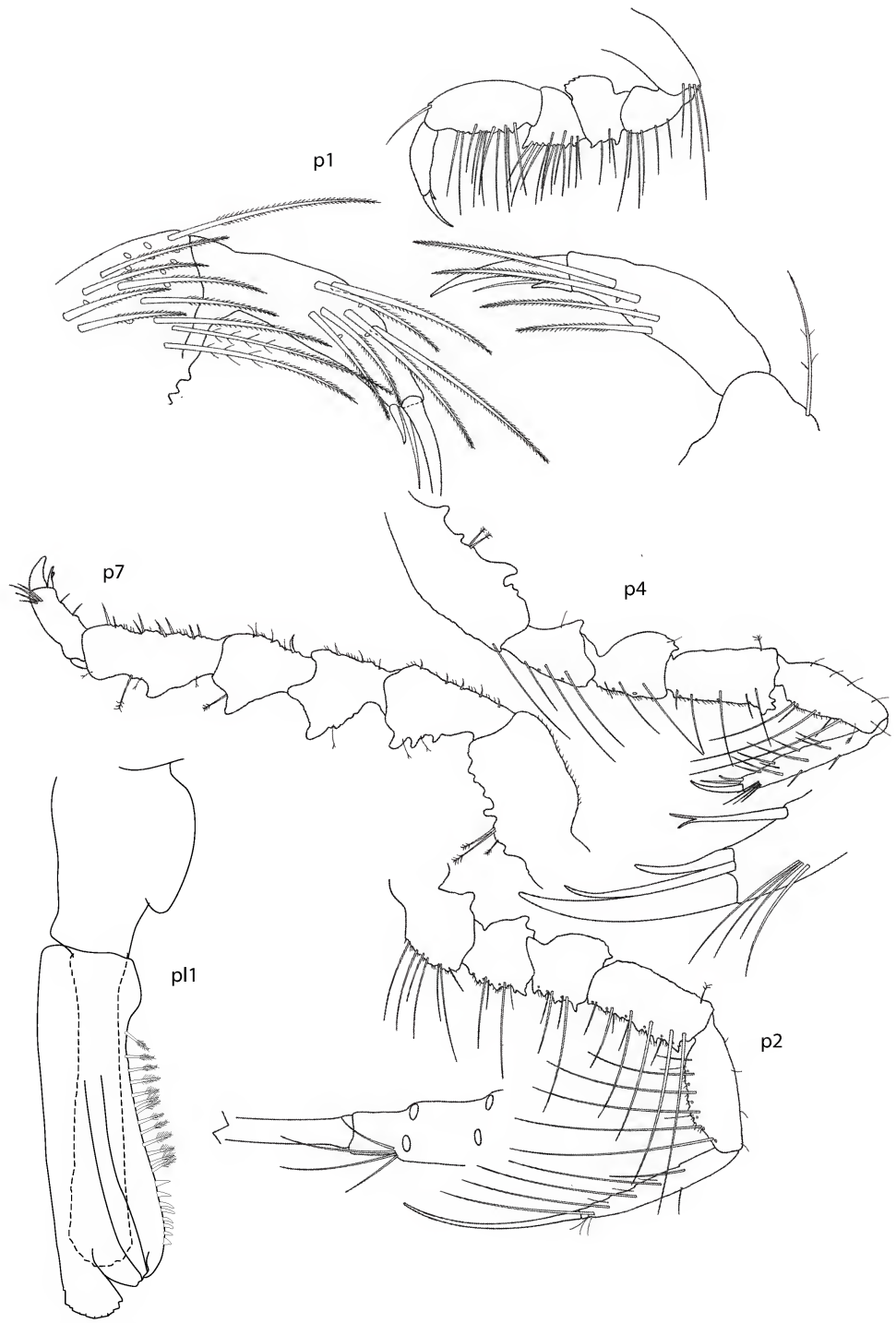

Figure 10. *Tasmarcturus lewisi* sp. nov. Male holotype, NMV J23745: p1, p2, p4, p7, pereopods 1, 2, 4 and 7 with details of distal articles; pl1, pleopod 1.

Distribution. Southeastern Australia, 37–40°S, 26–140 m depth.

Remarks. The head of *Tasmarcturus lewisi* has a rounded lateral profile, distinguishing it from the squarish profile of *T. erinae* and the conical tubercles of *T. simplicissimus*. This species is distributed within the latitudinal range of *T. erinae* but occurs over a wider depth range.

Tasmarcturus simplicissimus (Whitelegge, 1904)

Zoobank LSID. http://zoobank.org/urn:lsid:zoobank.org:act:DE7CA413-50A1-4F4F-9E95-2264DA513FF7

Figures 1d, 11, 12

Arcturus simplicissimus Whitelegge, 1904: 406–408, fig. 114a–c. – Springthorpe and Lowry, 1994: 132. – Poore et al., 2002: 256.

Types. Australia, NSW, off 'Wata Mooli' (now Wattamolla, 34°08'S, 151°07'E), 99–106 m (3 syntypes now lost).

Material examined. Neotype of *Arcturus simplicissimus* Whitelegge, 1904. Australia, NSW, E of Long Reef (33° 43'S, 151°46'E), 19 Dec 1985, 174 m (stn K85-21-08), AM P.90298 (male, 4.8 mm).

Figured material. Tas., eastern Bass Strait, 100 km NE of North Point, Flinders I, (38°52.36'S, 148°25.12'E), 140 m, 15 Nov 1981, (stn BSS 170), NMV J23735 (male, 6.1 mm); NMV J23741 (ovigerous female, 4.9 mm); NMV J23736 (ovigerous female, 8.8 mm); NMV J8758 (28 individuals, all stages, 3.0–7.3 mm).

Other material. Tas., Vic., NSW, c. 180 specimens from eastern Tas., eastern Bass Strait, eastern NSW; 35–42°S, 60–1096 m depth (see Museum Victoria database http://collections.museumvictoria.com.au/ for details). (All collected by WHOI epibenthic sled or SM grab by G.C.B. Poore et al., Museum Victoria.)

NSW, NE of Wollongong (34°20'S, 151°18'E), 13 Dec 1978, 161 m (stn K78-27-11), AM P.32669 (manca, 3.8 mm).

Qld. NE of Lady Elliot I. (24°02.7'S, 152°49.4'E), 150 m, 4 Jul 1984 (*Kimbla* stn 3), AM P.35630 (26 specimens), MTQ W34193 (15 specimens).

Description. Ovigerous female. Pereonites 2–4 swollen, taller and broader than more anterior and posterior segments, visibly pustulose between ridges and major sculpture, 2.9 times as long as greatest width. Pleotelson 0.3 times total body length.

Head ornamentation of strong tubercles in lateral view, comprising 3 pairs of submedian dorsal tubercles, first conical, second longer and thinner, third broadly conical, plus pair of small sublateral cones, all secondarily tuberculate; maxillipedal segment with microtuberculate transverse ridge with submedian and sublateral tubercles; ventrolateral margin tuberculate, with anterior short spine. Pereonites 1–4 each with pair of submedian and pair of sublateral blunt tubercles on transverse ridge; pereonites 5–7 with 5 pairs of blunt spinulose tubercles on transverse ridge. Submedian and sublateral tubercles on pereonites 1 and 2 simple; submedian processes on pereonite 3 erect, digitiform, spinulose, with prominent secondary process posteriorly. Pereonites 1–7 + maxillipedal segment with supracoxal semicircular plates on 2–4, weaker on 5–7. Pereonites 3 and 4 with pair of short, conical submedian tubercles anterior to major ridge and smaller pair posterior to ridge on 3 only, all secondarily spinulose. Pleonites 1 and 2 elevated, with pairs of submedian and sublateral tubercles; pleonite 3 with pair of submedian tubercles, with rounded marginal lobes; posterior pleotelson with pair of submedian and 1 medial tubercle, with triangular lateral wings; pleotelson tapering evenly to sharply rounded apex, tapered section 0.7 times as long as wide.

Antennule flagellum article 1 with 3 pairs plus 1 aesthetascs, article 2 with 2 aesthetascs. Antenna, fused articles (1 + 2) short, stout, with ventrolateral flange; article 5 2.7 times as long as article 4; flagellum of 3 articles, 0.7 times length of peduncle article 5.

Pereopod 1 propodus 2.3 times as long as wide. Pereopod 2 tuberculate, especially basis and flexor margin of carpus; dactylus unguis 1.2 times length of dactylus body. Pereopod 4 dactylus body 1.3 times as long as propodus, unguis setiform, 0.3 times length of dactylus body. Pereopods 5–7 with 2 to several tubercles on extensor margin of basis and ischium, 1 each on carpus and propodus. Pereopod 7 dactylus body 0.6 times as long as propodus, unguis stout, 0.5 times length of dactylus body.

Oostegites 1–4 supported by oval coxal plates; oostegites 5 a pair of adjacent oval discs.

Uropodal exopod 0.9 times length of endopod.

Male. Of even dimensions throughout length. Male pleopod 1 exopod little more than 3 times basal width; posterior face without erect lobes along groove; lateral margin bearing row of 13 pectinate setae; distomesial seta-bearing lamina well separated from apex by deep triangular notch and well exceeding it in length.

Distribution. Southeastern Australia, 24–42°S, 60–1096 m depth.

Remarks. Whitelegge (1904) described the species in detail but provided figures of only the antenna, maxilliped and pereopod 2. His remark that the body is not flexed between pereonites 4 and 5 is consistent with a species of Rectarcturidae. Key features noted by him suggest that this new abundant material can be referred to his species: the surface is covered with tubercles and ridges, is granulose and the granules are 'subspiniform', the head has four pairs of conical spines, the pereonites have a transverse ridge with submedian and lateral tubercles that tend to form a longitudinal ridge, and the pleotelson has tubercles on each side of the mesial line. Whitelegge's illustrations are consistent with the new material, notably the apparently setiform unguis of pereopod 2. His three syntypes are now lost (Springthorpe and Lowry, 1994). His description cannot be reconciled with that of any of the other non-flexed arcturid-like taxa, and a neotype is herein selected from a locality close by. The neotype is a small male, not as heavily sculptured as larger specimens. Whitelegge's species was included in *incertae sedis* by Poore et al. (2002).

This widespread species occurs over a considerable depth range. The pairs of conical tubercles on the head and the dominant one on pereonite 3 of the male are distinctive.

Acknowledgements

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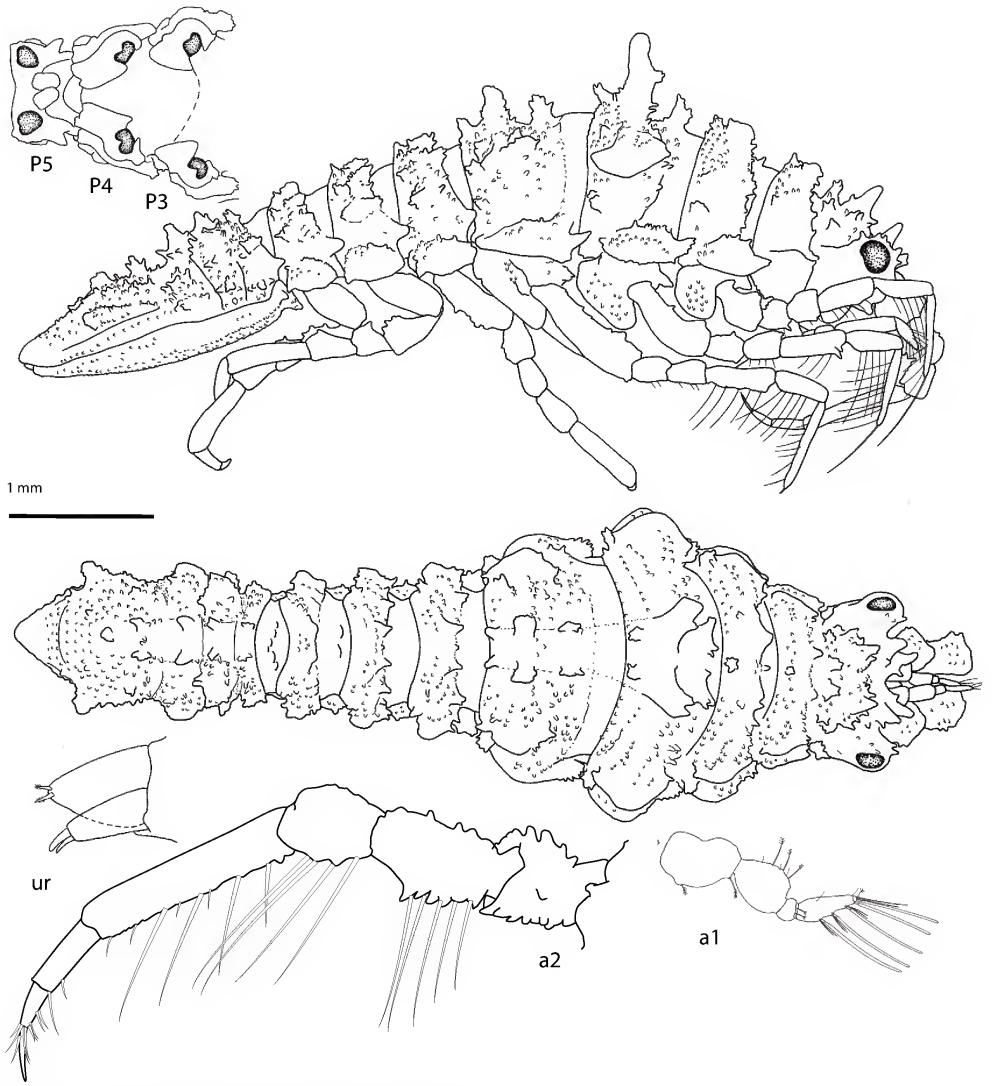

Figure 11. *Tasmarcturus simplicissimus* (Whitelegge, 1904). Female, NMV J23736: habitus; P3–P5, oostegites and coxal plates of pereonites 3–5. Male, NMV J23735: a1, antennule; a2, antenna; ur, uropodal rami.

Scheme and the Australian Research Council. Initial sorting of these specimens and preliminary separation of species were done by Tania Bardsley, who also made some of the pencil drawings. For the loan of other material I thank the Australian Museum, Sydney, the National Museum of Natural History, Washington, and Torben Wolff at the Zoological Museum, University of Copenhagen (now the Natural History Museum of Denmark). I appreciate the donation of specimens from Argentina by Angelika Brandt at the Zoological Museum and Institute, Hamburg. I thank Marilyn Schotte at the US Museum of Natural History, Washington, for observations on Schultz's material, and Wolfgang Wägele at the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, for looking at specimens of *Rectarcturus*.

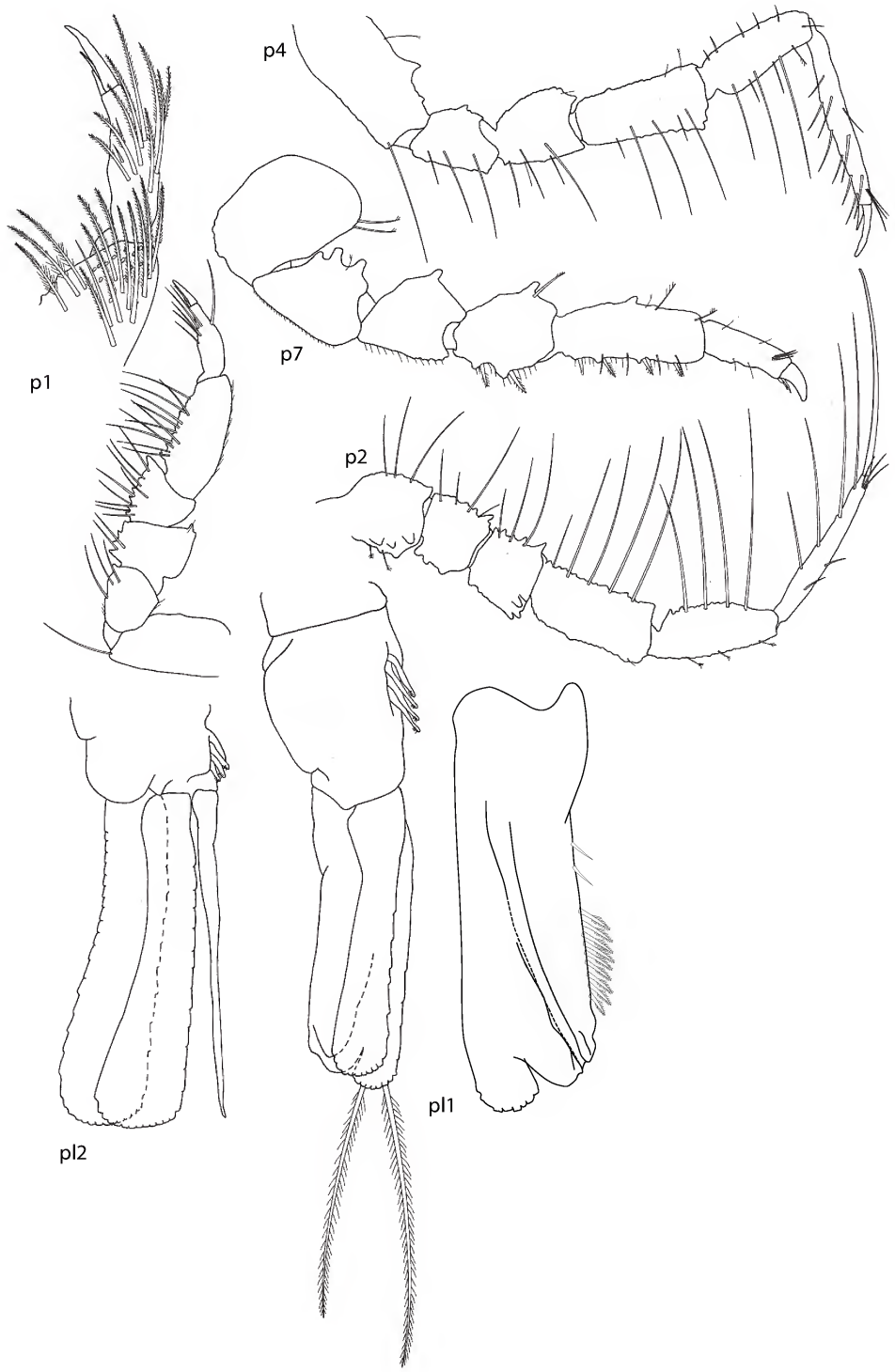

Figure 12. *Tasmarcturus simplicissimus* (Whitelegge, 1904). Male, NMV J23735: p1, p2, p4, p7, pereopod 1 with details of distal articles, pereopods 2, 4 and 7; pl1, pleopod 1 with detail of exopod; pl2, pleopod 2.

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New sea cucumber species from the seamounts on the Southwest Indian Ocean Ridge (Echinodermata: Holothuroidea: Aspidochirotida, Elasipodida, Dendrochirotida)

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Abstract

O'Loughlin, P.M., Mackenzie M. and VandenSpiegel D. 2013. New sea cucumber species from the seamounts on the Southwest Indian Ocean Ridge (Echinodermata: Holothuroidea: Aspidochirotida, Elasipodida, Dendrochirotida). *Memoirs of Museum Victoria* 70: 37–50.

Marine research program JC066 (JC067) in the southwest Indian Ocean on the RRS *James Cook* in November and December 2011 collected sea cucumbers with an ROV from the *Atlantis* Bank and *Coral* Seamount. Three new species are described: *Amphigymnas staplesi* O'Loughlin sp. nov.; *Pannychia taylorae* O'Loughlin sp. nov.; *Psolus atlantis* O'Loughlin sp. nov. Genera *Amphigymnas* Walsh and *Pannychia* Théel are reviewed. A lectotype for *Pannychia moseleyi* Théel is designated.

Keywords

JC066, *Atlantis* Bank, *Coral* Seamount, *Amphigymnas*, *Pannychia*, *Psolus*, lectotype

Introduction

The Natural Environment Research Council marine program JC066 (JC067) in the southwest Indian Ocean, embracing oceanography, biology and fisheries, and geology and geophysics, was conducted from the RRS *James Cook* in November and December 2011. Sampling was undertaken on the seamounts on the Southwest Indian Ocean Ridge: *Coral* Seamount, *Melville* Bank, *Middle of What* Seamount, *Sapmer* Bank and *Atlantis* Bank (fig. 1). Three specimens of sea cucumbers were collected by a submersible remotely operated underwater vehicle (ROV, 'Kiel 6000') and were sent to Museum Victoria for identification. The specimens represent new species of the synallactid genus *Amphigymnas* Walsh, 1891, the elasipodid genus *Pannychia* Théel, 1882, and the psolid genus *Psolus* Oken, 1815. We use Oken, 1815 as author of *Psolus* provisionally as we await the outcome of an application by Paulay and O'Loughlin to the ICZN (case 3598) for validation of Oken, 1815 as author of this genus. The three new species are described in this work, and the type specimens are lodged in the British Museum of Natural History.

Methods

Scanning electron microscope (SEM) images were taken by Didier VandenSpiegel after clearing the ossicles of associated soft tissue in commercial bleach, air-drying, mounting on aluminium stubs, and coating with gold. Observations were made using a JEOL JSM-6480LV SEM. Measurements were made with Smile view software.

Photos of specimens were taken in Museum Victoria by Melanie Mackenzie, in collaboration with Mark O'Loughlin, using an SLR Nikon D300S digital camera with a 60 mm Nikkor lens for large specimens, and a Leica DFC500 camera and microscope M205 high-resolution digital camera system with Auto Montage software for small specimens. Photos of live specimens were taken by photographer David Shale and used with permission.

Abbreviations

ICZN	The International Commission on Zoological Nomenclature, or the International Code of Zoological Nomenclature, as appropriate.
NERC	Natural Environment Research Council

NHMUK British Museum of Natural History (registration number prefix NHMUK).
NIWA New Zealand National Institute of Water and Atmospheric Research Ltd (est. 1992).
NMV Museum Victoria (registration number prefix F).

Order **Aspidochirotida** Grube, 1840

Family **Synallactidae** Ludwig, 1894

Amphigymnas Walsh, 1891

Amphigymnas Walsh, 1891: 199.—Deichmann, 1930: 106–107.

Diagnosis (this work). Genus of large synallactid species, up to at least 140 mm long; body wall calcareous, brittle, similar to that of the elasipodid family Deimatidae; mouth ventral, about 20 peltate tentacles; dorsal and lateral body with long conical calcareous papillae, including a ventrolateral series; body flat ventrally, tube feet in ambulacral series or scattered; anus subdorsal posterior; ossicles in body wall large table discs with many perforations, discs variably with or lacking spires comprising 3 or 4 pillars, sometimes cross-bars, pillars lacking distal spines or teeth, spires sometimes reduced to short unconnected pillars.

Type species. *Amphigymnas multipes* Walsh, 1891, by monotypy (= *Pannychia woodmasoni* Walsh, 1891, by priority according to the synonymy by Koehler and Vaney 1905) (Indian Ocean, Andaman Sea, 344–896 m). *Synallactes reticulatus* Sluiter, 1901 is a junior synonym (according to the synonymy by Koehler and Vaney, 1905).

Other included species. *Amphigymnas bahamensis* Deichmann, 1930 (Atlantic Ocean, Bahamas, 480 m); *A. staplesi* O'Loughlin sp. nov. (Southwest Indian Ocean Ridge, *Atlantis* Bank, 740 m).

Remarks. Koehler and Vaney (1905) examined numerous relevant specimens and judged that *A. multipes* Walsh, 1891 and *S. reticulatus* Sluiter, 1901 were junior synonyms of *P. woodmasoni* Walsh, 1891, the senior synonym based on the name sequence priority in Walsh (1891). They referred *P. woodmasoni* to *Synallactes* Ludwig, 1894. Deichmann (1930) examined the holotype of *A. multipes* and considered *Amphigymnas* Walsh, 1891 to be a good monotypic genus with *A. multipes* Walsh, 1891 the type species based on the single type specimen. She did not examine any *P. woodmasoni* specimens and acknowledged that she was not able to judge whether *A. multipes* and *P. woodmasoni* were conspecific. She rejected the referral of the species to *Synallactes* by Koehler and Vaney (1905) and wrote: '*Amphigymnas* is as good a genus as *Synallactes* and *Bathyplotes* with neither the solid rod-like spire of the typical *Synallactes* nor the long spire with the numerous cross beams of *Bathyplotes*. The deposits remind one so much of those found in certain Deimatidae that at first one would be inclined to place it in that group. It is only when one notes the presence of respiratory trees as well as smaller tables with more or less complete spire and the long synallactid-like supporting rods that one realizes that the genus belongs in the Synallactidae'. She added the species *A. bahamensis* Deichmann, 1930. Solís-Marín and Laguarda-Figueras (2004) listed *Pannychia woodmasoni* Walsh, 1891 (incorrectly as *Synallactes woodmasoni* Koehler and Vaney, 1905) and *Synallactes reticulatus* as junior synonyms of *A. multipes*. We uphold the work of Deichmann (1930) by recognizing the genus *Amphigymnas* Walsh, 1891, and the work of Koehler and Vaney (1905) by confirming *Pannychia woodmasoni* Walsh, 1891 as the type species.

Walsh (1891) diagnosed his genus *Amphigymnas* as: 'Body ovoid with narrow tail-like extremities; soft and appears to have been surrounded by a jelly-like material when fresh. Feet very numerous over the whole of the trivium and placed more or less irregularly. Lateral margins with two or three rows of long processes. Back covered with processes except near the mouth and anus where the body tapers and where the dorsal surface is naked; mouth terminal, small; tentacles 15, very small and retracted; anus terminal, small. Calcareous bodies moderate sized, irregularly rounded, many-holed plates somewhat like those of *Pannychia*. Calcareous ring of 5 small pieces loosely connected.' The type specimen of *A. multipes* was 80 mm long, 22 mm wide midbody, the lateral processes about 15 mm long, shorter processes on the back. Koehler and Vaney (1905) examined the type specimen and judged that it was damaged and incomplete. This may explain why Walsh (1891) could describe the type specimen as being 'soft' and the calcareous ring as comprising 'five small pieces loosely connected', neither of which is true for a synallactid.

Deichmann (1930) diagnosed *Amphigymnas* as: 'Closely related to *Synallactes*, but in its texture resembling a Deimatid. Skin thin, glass-like, filled with large deposits, derived from tables; spires 3–4 pillared with 1–2 cross beams and no teeth on top, often reduced or entirely absent, so the large plates resemble the plates found in the Deimatiids; dorsally large, conical papillae, ventrally a lateral row of large and conical pedicels, and a midventral row of smaller ones, filled with numerous supporting rods and a rudimentary endplate'.

The distinctive diagnostic characters of *Amphigymnas* are: long, conical, dorsal calcareous papillae, including a ventrolateral series; flat ventrally with small tube feet in ambulacral series or scattered over ventrum; brittle calcareous outer body wall texture resulting from the presence of many large table discs with variably complete spires. We suspect that the three species assigned to *Amphigymnas* are not congeneric. The dorsal table discs with their central cross, four large central perforations, and four-pillared spires, are similar for *A. multipes* Walsh and *A. staplesi* O'Loughlin sp. nov., but quite different from the table discs with numerous small perforations and predominantly three-pillared spires illustrated for *A. bahamensis* Deichmann. And we judge that species with a distinctly ambulacral series of tube feet would not be congeneric with species that have tube feet scattered over the ventrum.

We note that the first description of *S. reticulatus* was in Sluiter (1902). This paper was published after Sluiter (1901) provided an illustrated description of *S. reticulatus* in the *Siboga* report. Sluiter, 1901 is given here as the date of authorship of the species.

Amphigymnas staplesi O'Loughlin sp. nov.

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Figures 1, 2, 3, 4

Material examined. Holotype. Southwest Indian Ocean Ridge, *Atlantis* Bank, 32.71°S 57.28°E, 707 m, JC066, event 8–3, parent no. 2605, specimen no. JC066–3666, ROV, 9 Dec 2011, NHMUK 2013.4.

Description. Body flat ventrally, domed to subrectangular elevation dorsally, 140 mm long, 30 mm wide midbody; mouth ventral, anus subdorsal posterior; body wall firm, thick, outer wall thin, calcareous, brittle; two paired, spaced single series of dorsolateral, conical papillae (four series across dorsally), each papilla up to about 7 mm long; pair of long dorsal posterior papillae up to about 12 mm long; two single series of larger ventrolateral conical papillae each up to about 15 mm long, about 18 papillae in each series; oral disc with ventral marginal continuous series of conical papillae, tapering in size from largest anteriorly to smallest posteriorly, total of about 30 papillae around oral disc; posterior to the oral disc a ventral transverse series of small conical papillae, irregular lengths; body with median ventral groove with single zigzag series of small tube feet on each side of groove, tube foot diameters about 0.6 mm, about 70 tube feet per series; irregular paired lateroventral series of larger tube feet, diameters about 0.8 mm, about 45 tube feet per lateral paired series; solid synallactid calcareous ring, lacking free-hanging tentacle ampullae; longitudinal muscles undivided; tuft of long thin gonad tubules with some basal branching, male; single polian vesicle; respiratory tree branches about a half body length.

Dorsal body wall ossicles tables, discs with slightly lobed rounded margin, 160–240 μm across, disc with central cross, 4 large central perforations, up to 17 outer perforations, spires with 4 pillars, 2 cross-bars, pillars tapered to a point, lacking distal spines or teeth, spires up to 80 μm long. Dorsal and lateral papillae with irregular thick tables, discs up to 400 μm

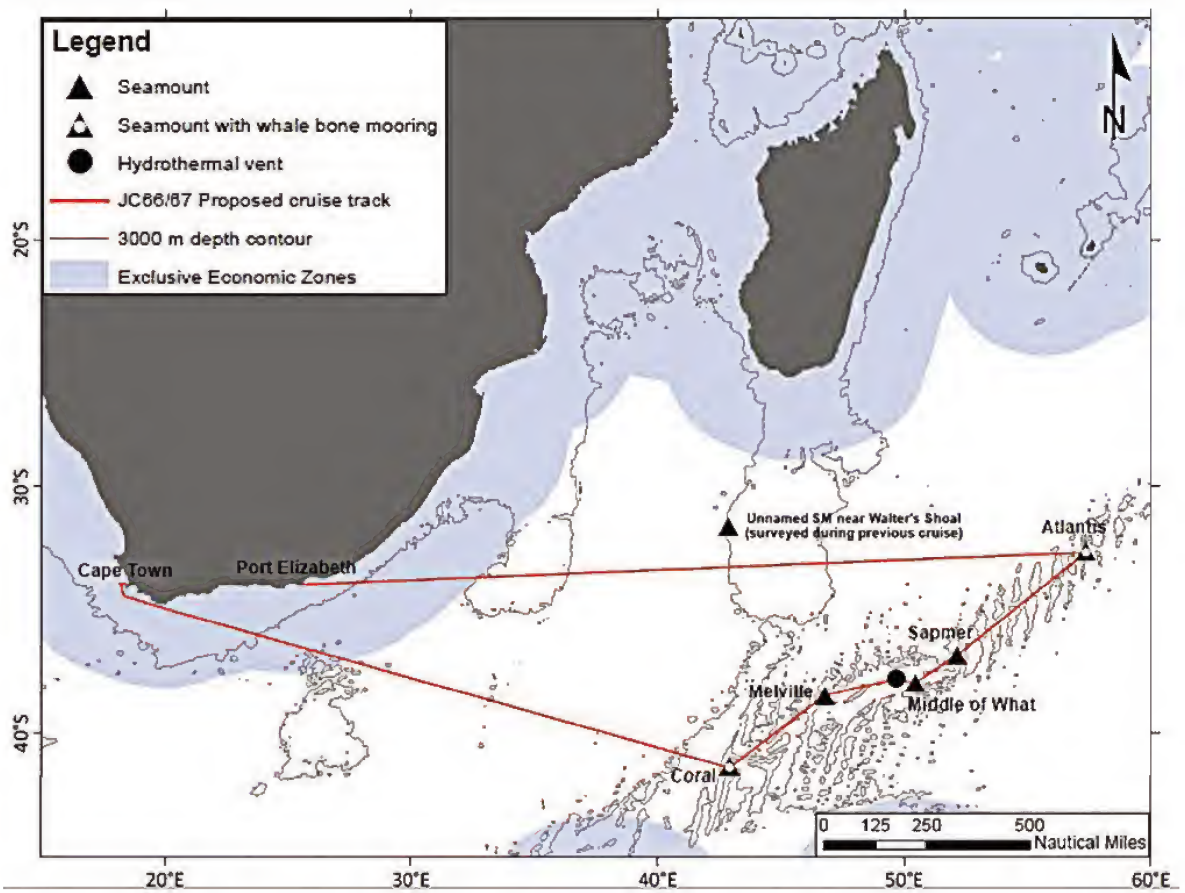

Figure 1. RRS *James Cook* cruise map showing the Southwest Indian Ocean Ridge and the locations of the five seamounts that were visited during NERC JC066. The hydrothermal vent system studied during JC067 is indicated by the filled circle near *Middle of What* seamount. The sea cucumbers described in this study were collected from the *Atlantis* Bank, northeast on the Ridge, and the *Coral* Seamount, southwest on the Ridge.

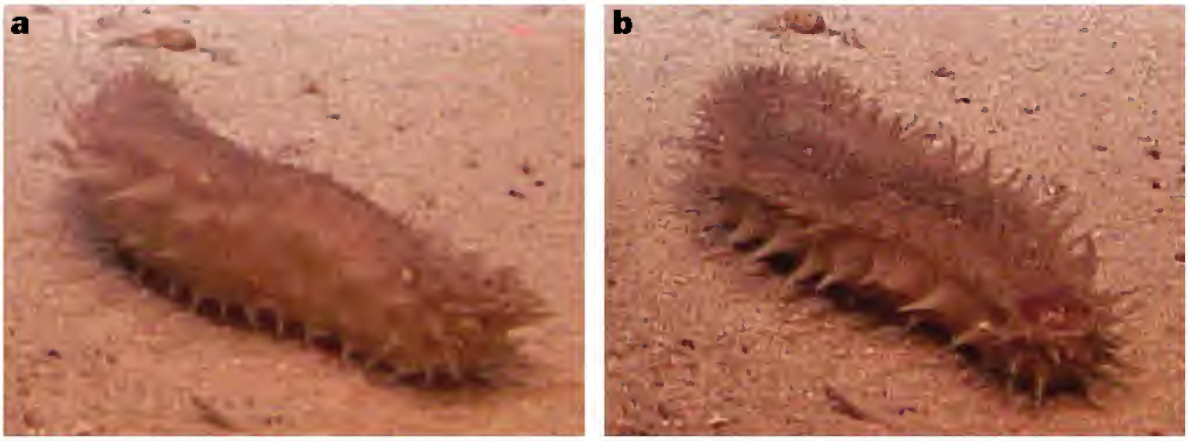

Figure 2. Photos of live holotype specimen of *Amphigymnas staplesi* O'Loughlin sp. nov. (*in situ* on *Atlantis* Bank; extracted from ROV video footage during cruise JC066; copyright AD Rogers University of Oxford/NERC; specimen NHMUK 2013.4). a, left ventrolateral view of rolling specimen with oral end right and left series of long, conical ventrolateral papillae prominent (up to 15 mm long); b, ventral view of rolling specimen with mouth right, ambulacral series of small tube feet evident, and left ventrolateral series of conical papillae again prominent.

across, many outer perforations, high multiperforate spires, predominantly 4-pillared spires. Ventral body wall with mostly smaller thick 4-pillared tables, spires truncate, pillars lacking cross-bars, discs irregular, typically 160 μm across. Midventral tube feet endplates with very irregular branches creating perforations, diameters up to 520 μm; tube foot support rods straight to curved, widened midrod, irregular blunt marginal projections, rare perforations midrod and distally, rods up to 480 μm long; tube feet with very irregular tables. Tentacles with slightly curved rods, spinous on outer margin, about 480 μm long.

Colour. Live: body reddish-brown. Preserved: body brown, papillae off-white.

Distribution. Southwest Indian Ocean, *Atlantis* Bank, 740 m.

Etymology. Named for David Staples of the Marine Biology Section of Museum Victoria, in appreciation of his contribution during the JC066 voyage and his facilitation of the loan of these specimens to Museum Victoria that has made this work possible.

Remarks. We refer our new species to *Amphigymnas* Walsh, 1891 on the bases of: brittle, calcareous outer body wall texture resulting from the presence of many large tables; long, conical, dorsal calcareous papillae, including a ventrolateral series; flat ventrum with small tube feet in ambulacral series. The three species currently assigned to *Amphigymnas* are distinguished by: dorsal tables have rare 3-pillared truncate spires, and ventral tube feet are in median series only (*A. bahamensis* Deichmann, 1930); dorsal tables have rare truncate 4-pillared spires, and ventral tube feet are inconspicuous and scattered (*A. multipes* Walsh, 1891); dorsal tables have predominantly complete 4-pillared spires, and ventral tube feet are in three discrete ambulacral series (*A. staplesi* O'Loughlin sp. nov.).

Order **Elasipodida** Théel, 1882

Family **Laetmogonidae** Ekman, 1926

Pannychia Théel, 1882

Pannychia Théel, 1882: 88.—Fisher, 1907: 709.—Mitsukuri, 1912: 207.—Pawson, 1965: 22.—Pawson, 1970: 53.—Hansen, 1975: 72.
Laetmophasma Ludwig, 1893: 109.—Ludwig, 1894: 85.

Diagnosis (emended from Théel, 1882, and Hansen, 1975). Mouth subventral, lacking circumoral papillae, tentacles about 20, non-retractile; anus dorsoposterior; numerous slender papillae of variable length over the dorsal and lateral body; lateral ventral ambulacra with tube feet in single series, midventral ambulacrum with smaller tube feet; body wall and papillae with numerous wheel ossicles and significantly smaller, slightly concave round to oval plate ossicles; wheels with teeth between larger outer spokes and with fewer small hub spokes, hub covered by a membrane; small plates with about 15 perforations, including 2 large and 2 smaller central ones.

Type species. Pannychia moseleyi Théel, 1882 (monotypy) (Tasman Sea).

Synonyms (by Hansen, 1975): *Laetmophasma fecundum* Ludwig, 1893; *P. moseleyi mollis* Savel'eva, 1933; *P. moseleyi* var. *henrici* Ludwig, 1894; *P. moseleyi vigulifera* Ohshima, 1915; *P. multiradiata* Sluiter, 1901; *P. pallida* Fisher, 1907.

Other included species. Pannychia taylorae O'Loughlin sp. nov. (below).

Remarks. Hansen (1975) judged that specimens of *P. moseleyi* Théel, 1882 showed a wide range of variations and as a consequence synonymized six species and varieties with *P. moseleyi.* In collaboration with Niki Davey (NIWA) we

Figure 3. Photos of holotype of *Amphigymnas staplesi* O'Loughlin sp. nov. (preserved, 140 mm long, NHMUK 2013.4). a, dorsal view of holotype with oral end left; b, ventrolateral view of holotype with oral end left; c, ventral view of oral region showing marginal and post-oral transverse papillae; d, midbody ventral view showing discrete ambulacral series of tube feet.

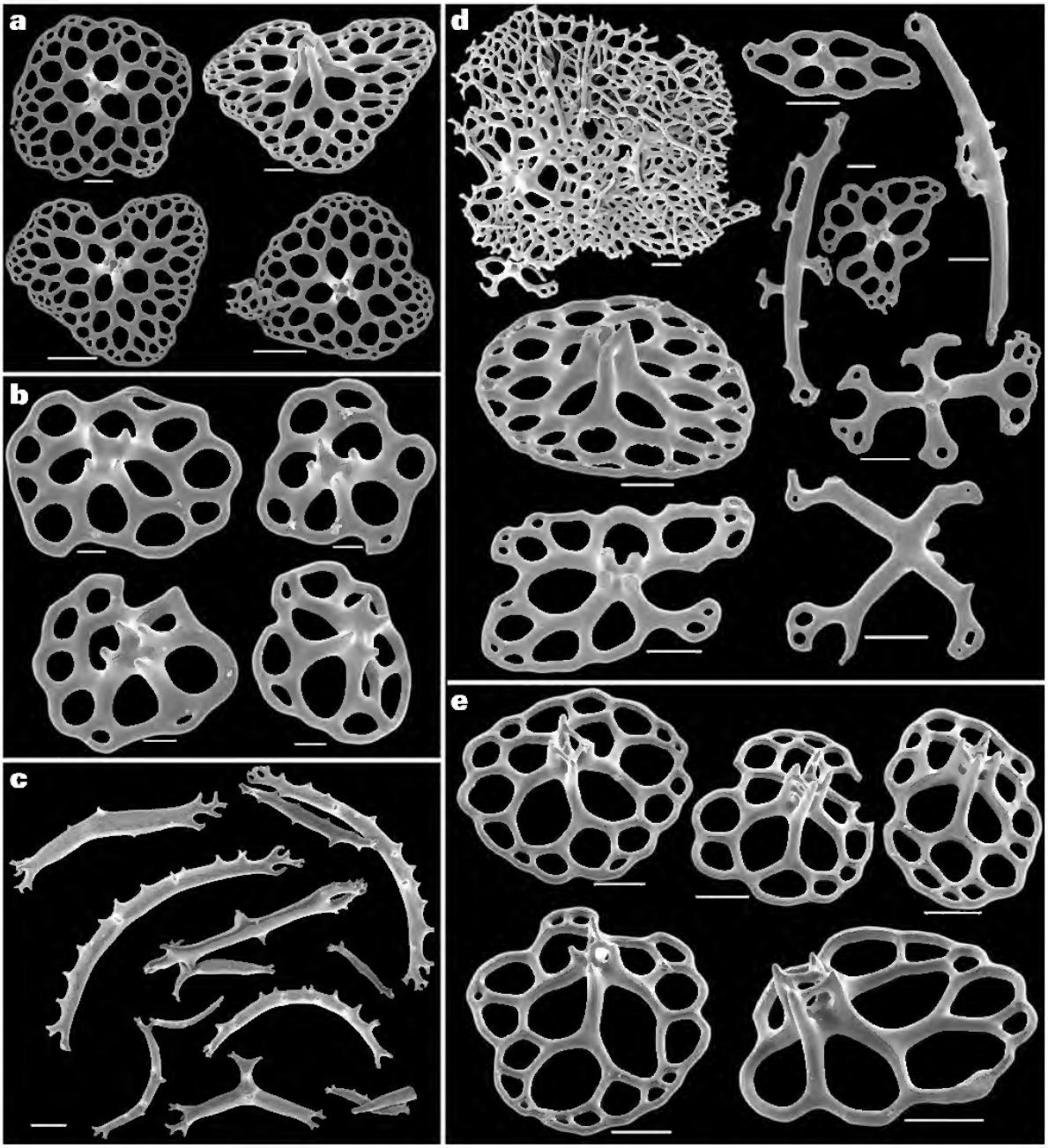

Figure 4. SEM images of ossicles from holotype of *Amphigymnas staplesi* O'Loughlin sp. nov. (NHMUK 2013.4). a, tables from lateral papilla (scale bars 50 μm); b, tables with truncate spires from ventral body wall (scale bars 20 μm); c, tentacle rods with outer surface spines (scale bar 50 μm); d, ventrolateral tube foot endplate (top left, scale bar 100 μm), tube foot support rods, very irregular and under-developed tables (scale bars 50 μm); e, tables from dorsal body wall with distal spires lacking teeth (scale bars 50 μm).

examined numerous specimens from the eastern Australian, New Zealand and Antarctic Admiralty Seamount regions and found some consistent morphological differences that are congruent with molecular phylogenetic data. Some consistent morphological characters for species that we observed are colour, numbers of tube feet, maximum wheel size, and numbers of large outer and small inner spokes in the wheels. Based on morphological and phylogenetic data we distinguish *P. moseleyi* and two additional species of *Pannychia* from these regions (Davey *et al.*, in preparation). We anticipate that molecular data will invite a review of the numerous current synonymies.

Table 1. Morphological characters for the lectotype of *Pannychia moseleyi* Théel, 1882 and holotype of *P. taylorae* O'Loughlin sp. nov.

Morphological characters	***P. moseleyi*** Théel, 1882 lectotype	***P. taylorae*** O'Loughlin sp. nov. holotype
Preserved length	200 mm	180 mm
Residual preserved colour	dark violet dorsally	off-white
Ventrolateral tube feet per lateral series	29–30	19
Midventral tube feet total number	55	23
Maximum wheel diameter	240 μm	328 μm
Outer spoke number	11–13	9–15
Hub spoke number	4, none 6	5–7, none 4

Pannychia moseleyi Théel, 1882

Synonymy (excluding Hansen, 1975, synonyms). *Pannychia moseleyi* Théel, 1882: 88–90, pl. 17 figs 1–2, pl. 32 figs 1–13.—Mitsukuri, 1912: 207–212, fig. 38.—Ohshima, 1915: 235–236, pl. 8 figs a, b.—Djakonov, Baranova and Savel'eva, 1958: 360.—Pawson, 1965: 22.—Pawson, 1970: 53.—Hansen, 1975: 72–75, fig. 26.—Cherbonnier and Féral, 1981: 365–366, fig. 5A–I.

Lectotype (designated in this work). Syntype, Australian continental slope off Sydney, 34°8'S 152°0'E, 1739 m, at *Challenger* stn 164, NHMUK (18)83.6.18.52.

Paralectotype (designated in this work). Syntype, New Zealand, off East Cape on the North Island of New Zealand, 37°34'S 179°22'E, 1281 m, *Challenger* stn 169, NHMUK (18)83.6.18.53.

Material examined. Tasman Sea, off New South Wales, Wanganella Bank, 521–1008 m, NMV F94007, NMV F94008, NMV F98046, NMV F98059, NMV F98695, NMV F98469; S. Norfolk Ridge, 469 m, NMV F98477; off Tasmania. Cascade Seamounts, 600–1000 m, NMV F136931, NMV F136933, NMV F136934, NMV F136935, NMV F136937. New Zealand, Challenger plateau, 526–575 m, NIWA 30721, NIWA 30722, NIWA 30685; Chatham Rise, 532 m, NIWA 30636.

Description of lectotype (from Théel, 1882; see table 1). Up to about 200 mm long, 40 mm wide, subcylindrical dorsally and laterally, flat ventrally; mouth anterior, ventral, anus posterior, terminal; 20 tentacles; single series of 29–30 tube feet on each lateroventral ambulacrum, irregular double series of 55 smaller tube feet midventrally; irregular series of up to 100 long to very short dorsolateral and lateral papillae, biggest up to 20 mm long, bare middorsally; calcareous ring rudimentary, fragile, spongy; ossicles large and small wheels; large wheels up to 240 μm diameter, 11–13 outer spokes, 4 inner spokes, lobes/teeth between bases of spokes wide; small wheels 52 μm long.

Colour. Preserved: white grey; dark violet dorsally; ends of papillae whitish; ends of tentacles and tube feet yellowish.

Remarks. Théel (1882) described his new genus and species *P. moseleyi* for two specimens. Based on the inner spoke numbers noted by Théel (1882), in our experience diagnostically reliable, we judge that the larger syntype from off Sydney that is in fairly good condition (*Challenger* stn 164) is probably not conspecific with the smaller very damaged syntype from off New Zealand (*Challenger* stn 169). We designate the *Challenger* stn 164 syntype as the lectotype (NHMUK (18)83.6.18.52).

Pannychia taylorae O'Loughlin sp. nov.

Zoobank LSID. http://zoobank.org/urn:lsid:zoobank.org:act:77705FFB-3331-44AC-9266-BDD53F760E49

Figures 1, 5, 6, 7, table 1

Material examined. Holotype. Southwest Indian Ocean Ridge, *Coral* Seamount, 41.38°S 42.85°E, 1286 m, JC066, specimen no. JC066–204, ROV, 13 Nov 2011, NHMUK 2013.5.

Description. Body wall thick, soft; body with low elevation, rounded anteriorly and posteriorly, slight brim marginally, body 180 mm long, up to 45 mm wide; numerous dorsal and lateral thin papillae evident in photo of live animal, few remaining on preserved holotype, up to about 15 mm long; mouth subventral, anus dorsoposterior; damaged orally, 16 of 20 tentacles remaining; single series of 19 tube feet on each lateroventral ambulacrum, median ventral ambulacrum with 23 smaller tube feet in paired series posteriorly, more scattered anteriorly.

Ossicles in dorsal and ventral body wall and dorsal papillae abundant wheels and small concave oval to round plates; wheels up to 328 μm diameter, 9–15 outer spokes, rounded triangular teeth between the bases of the spokes, central wheel hub with 5–7 spokes, predominantly 6 never 4, hub covered by a membrane; small plates about 56 μm long, up to about 70 μm long, irregularly oval to round, slightly lobed margin, slightly concave, about 15 perforations, typically 11 marginally with 4 centrally, sometimes 2 larger centrally. Tentacle ossicles rarely branched, curved rods with thick spines on outer surface, rods up to 350 μm long.

Colour. Live: body pale blue, tentacle and tube foot ends pale brown. Preserved: body off-white, tentacle and tube feet ends pale brown.

Distribution. Southwest Indian Ocean, *Coral* Seamount, 1286 m.

Etymology. Named for Michelle Taylor (Department of Zoology, University of Oxford) in appreciation of Michelle's tireless and efficient work in organizing the biological science team and processing the collections for voyage JC066.

Figure 5. Photos of live holotype specimen of *Pannychia taylorae* O'Loughlin sp. nov. (NHMUK 2013.5). a, photo of live holotype specimen (*in situ* on *Coral* Seamount; taken by ROV during cruise JC066; copyright AD Rogers University of Oxford/NERC); b, ventral view of live holotype (with two commensal polynoid specimens) (photo taken by David Shale and used with permission).

Figure 6. Photos of holotype of *Pannychia taylorae* O'Loughlin sp. nov. (preserved, 180 mm long, NHMUK 2013.5). Ventral view of holotype with oral end below and midventral tube feet more numerous posteriorly. Insert with ventral view of damaged oral region showing non-retractile tentacles.

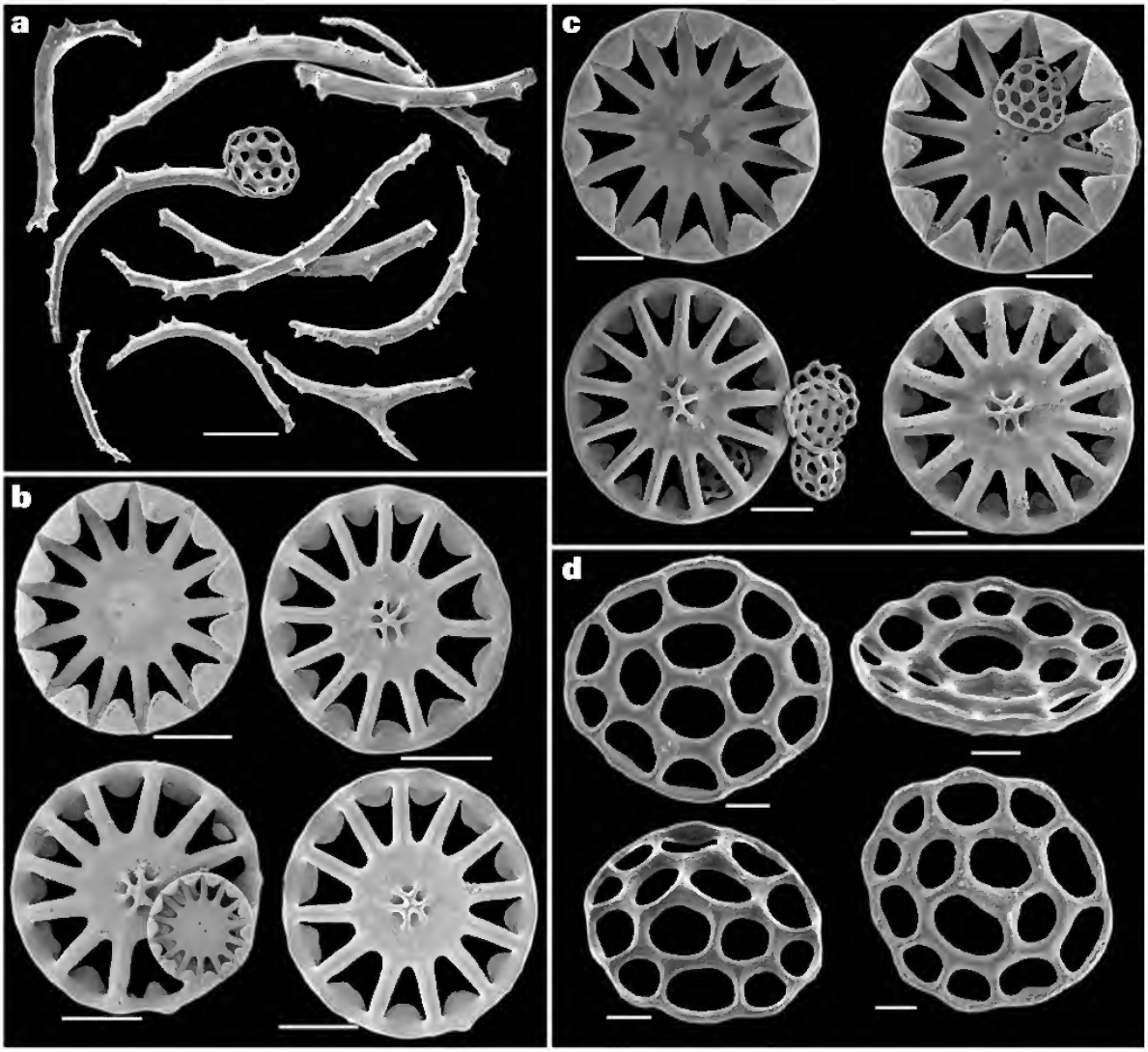

Figure 7. SEM images of ossicles from holotype of *Pannychia taylorae* O'Loughlin sp. nov. (NHMUK 2013.5). a, tentacle rods with outer surface spines (scale bar 50 μm; small plate ossicle probable contaminant from body wall); b, wheels from dorsal body wall (scale bars 100 μm); c, wheels and small plates from dorsal papilla (scale bars 50 μm); d, small concave plates from ventral body wall (scale bars 10 μm).

Remarks. The single type specimen of *P. taylorae* O'Loughlin sp. nov. is closest in its morphological characters to the Antarctic Admiralty Seamount specimens that we have examined, but we judge that they are not conspecific. These specimens represent a species of *Pannychia* that is quite distinct morphologically and genetically from *P. moseleyi* (Davey *et al.*, in preparation). In table 1 we detail the significant morphological diagnostic differences between *P. taylorae* O'Loughlin sp. nov. and *P. moseleyi*.

Order **Dendrochirotida** Grube, 1840

Family **Psolidae** Burmeister, 1837

Psolus Oken, 1815

Diagnosis (from Mackenzie and Whitfield, 2011). Species of Psolidae with large imbricating or contiguous dorsal and lateral scales; ventrolateral scales at margin clearly demarcated from

thin sole that lacks conspicuous scales; tube feet absent dorsally and laterally, except sometimes present orally and anally; 10 dendritic tentacles, eight large and two small ventrally.

Remarks. Oken, 1815 was rejected for systematic validity by ICZN (1956, opinion 417). Paulay and O'Loughlin have submitted an application to ICZN for Oken, 1815 validity as author of *Psolus* (case 3598). We use the authorship here provisionally.

Psolus atlantis O'Loughlin sp. nov.

*Zoobank LSID. http://zoobank.org/*urn:lsid:zoobank.org:act:DE8353F7-D506-4264-8638-9FF3EA29254A

Figures 1, 8, 9, 10

Material examined. Holotype. Southwest Indian Ocean Ridge, *Atlantis* Bank, 32.72°S 57.25°E, 1117 m, JC066, event 8–5, parent no. 2547, specimen no. JC066–3686, ROV, 10 Dec 2011, NHMUK 2013.6.

Description. Body oval with slight posterior rounded taper, body 28 mm long, up to 17 mm wide, up to 7 mm high at oral cone; dorsal and lateral body covered by imbricating large multilayered scale ossicles of variable sizes, up to 7 mm wide, not perforated for tube feet, lateral marginal scales very small; dorsal and lateral scales sparsely but distinctly granular, granular appearance caused by pyramidal projections on the multilayered scale ossicles, not caused by small surface ossicles; oral cone dorsal with slight pyramidal elevation, 5 triangular interradial oral valves separated by 5 narrow radial oral scales, oral cone not discrete with dorsal scales encroaching basally on oral scales; anus dorsal posterior, surrounded by an irregular cluster of small scales.

Distinct thin-walled sole, overhung marginally by small lateral scales; inner marginal, irregular, single to zigzag to double series of tube feet with diameters about 0.6 mm; outer marginal, single series of smaller inconspicuous tube feet with diameters about 0.3 mm; a few tube feet on midventral ambulacrum anteriorly and posteriorly, but lacking midventral series of tube feet.

Ossicles in central sole small, thick, smooth crosses and plates with up to 7 perforations, ossicles up to 200 μm long; inner tube feet endplates with irregular small perforations centrally and irregular larger perforations marginally, margin smooth and not denticulate, endplate diameters up to about 400 μm; tube foot support ossicles irregular curved plates with more perforations than the ossicles in the sole, up to about 20, lengths up to about 200 μm long.

Colour. Live: red dorsally. Preserved: white.

Distribution. Southwest Indian Ocean, *Atlantis* Bank, 1117 m.

Etymology. Named, in apposition, for the *Atlantis* Bank on the Southwest Indian Ocean Ridge from which this specimen was collected.

Remarks. The morphological characters that distinguish, in combination, *P. atlantis* O'Loughlin sp. nov. from all other *Psolus* Oken, 1815 species are: five discrete triangular oral

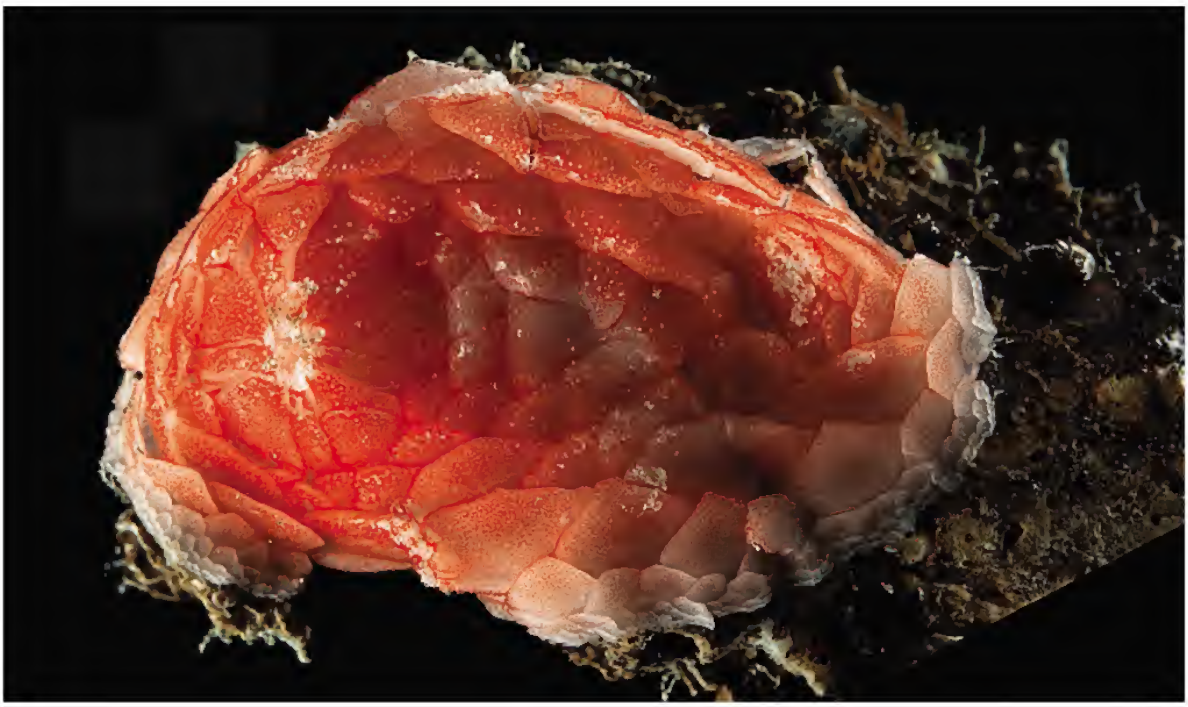

Figure 8. Photo of dorsal view of live holotype specimen of *Psolus atlantis* O'Loughlin sp. nov., attached to a rock fragment from *Atlantis* Bank collected during cruise JC066 (oral end left; specimen NHMUK 2013.6; photo taken by David Shale and used with permission).

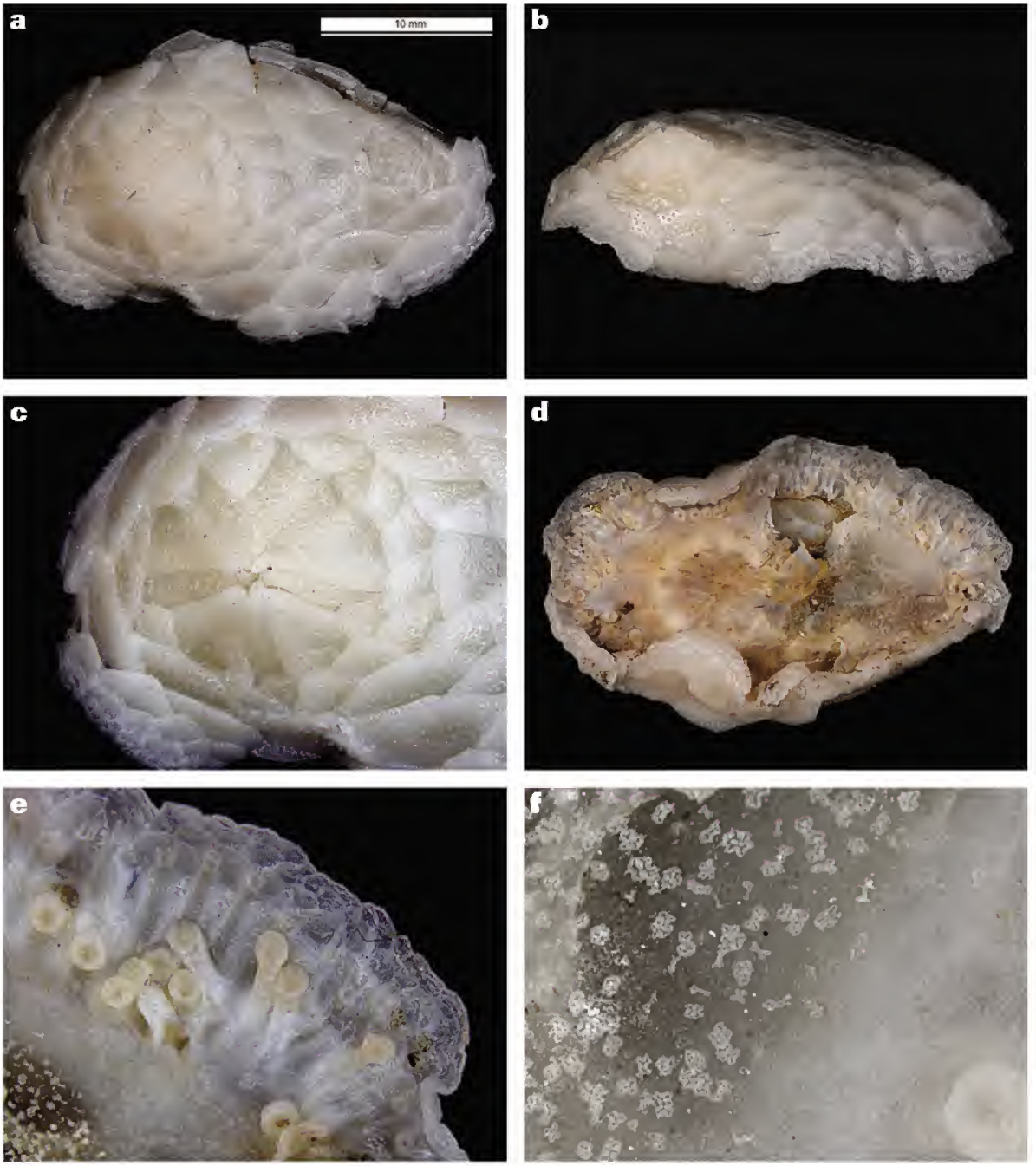

Figure 9. Photos of holotype of *Psolus atlantis* O'Loughlin sp. nov. (preserved, 28 mm long, NHMUK 2013.6). a, dorsal view of holotype with oral valves left; b, dorsolateral view of holotype showing elevated oral valves; c, view of five triangular interradial oral valves and five narrow radial oral valves; d, ventral view of sole; e, ventral view of margin of sole showing inner series of large tube feet and outer series of small inconspicuous tube feet; f, view of sole showing scattered, small perforated plate and cross ossicles.

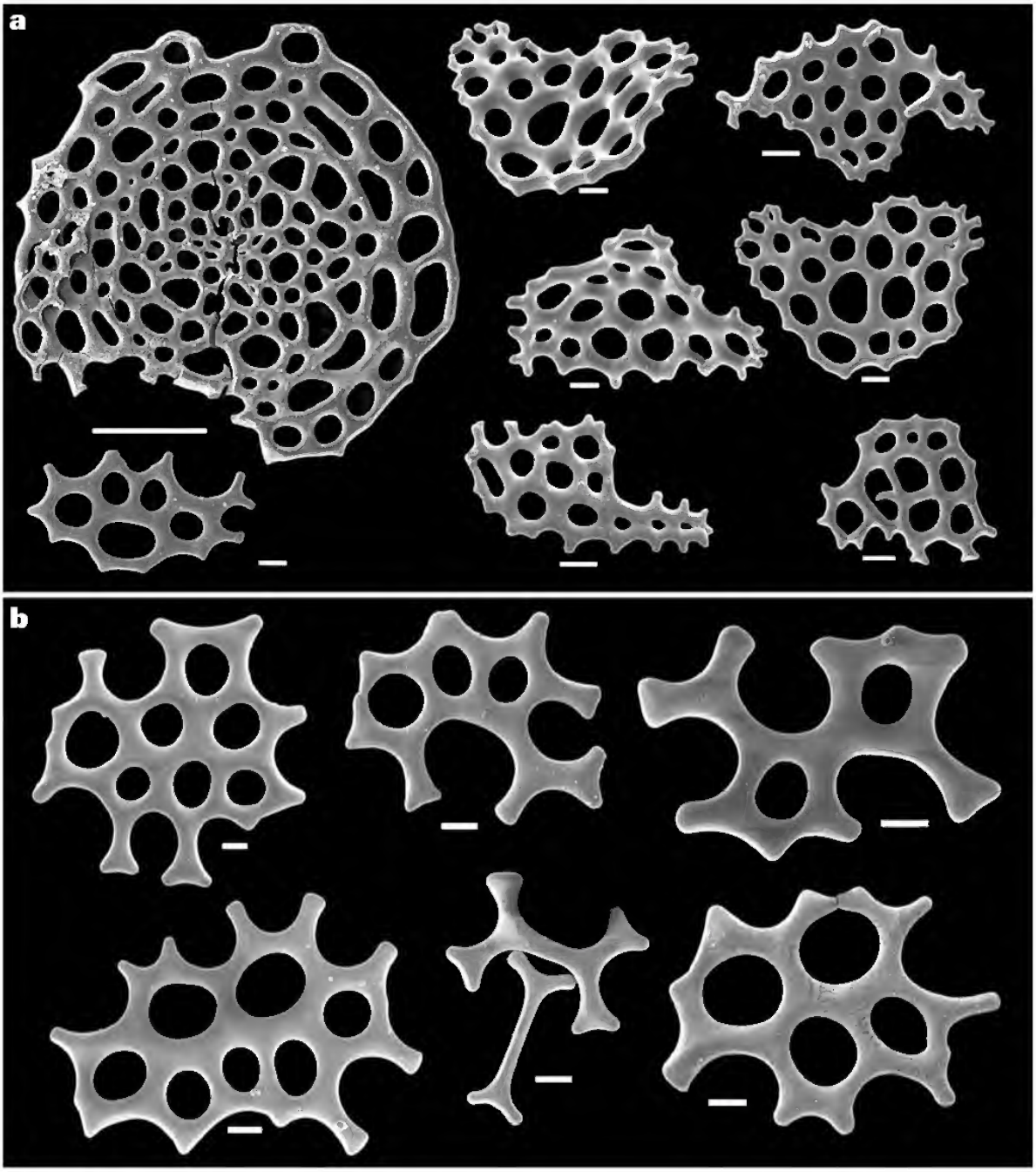

Figure 10. SEM images of ossicles from holotype of *Psolus atlantis* O'Loughlin sp. nov. (NHMUK 2013.6). a, tube foot endplate (top left; scale bar 100 μm) and tube foot support ossicles (scale bars 20 μm); b, small plates and crosses from central sole (scale bars 20 μm).

valves separated by single, thin rectangular oral plates; conspicuously granuliform oral, dorsal and lateral scales; absence of a midventral ambulacral series of tube feet; absence of any dorsal ossicles in addition to the large scales; small thick smooth perforated plate ossicles with fewer than eight perforations in the midsole; absence of cups or concave plate ossicles in the sole. We note the significant depth of occurrence (1117 m) of *P. atlantis*, relative to the occurrence of most *Psolus* species. We have compared *P. atlantis* with other southern *Psolus* species directly or in the works of Carriol and Féral (1985), Cherbonnier (1974), Deichmann (1930), Ekman (1925), Ludwig and Heding (1935), Mackenzie and Whitfield (2011), O'Loughlin and Whitfield (2010), Thandar (2009), Théel (1886a, 1886b) and Vaney (1906, 1914).

Acknowledgements

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The Psolidae of New Zealand and some additions to the Macquarie Ridge fauna (Echinodermata: Holothuroidea: Psolidae)

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Abstract

Davey, N. and Whitfield, E. 2013. The Psolidae of New Zealand and some additions to the Macquarie Ridge fauna (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 70: 51–67.

One new species of *Psolus* and four new species of *Psolidium* are described from New Zealand and Macquarie Ridge: *Psolus macquariensis* sp. nov., *Psolidium aequm* sp. nov., *Psolidium kermadeci* sp. nov., *Psolidium marriotti* sp. nov. and *Psolidium ramum* sp. nov. *Psolus neozelanicus* is a subjective junior synonym of *Psolus antarcticus*. New material is assigned to *Psolus squamatus* (Müller) var. *segregatus* Perrier and the diagnostic characters noted. *Psolidium whittakeri* O'Loughlin and Ahearn, formerly known only from Antarctic waters, also occurs off New Zealand. Ten species of the family Psolidae are now known from New Zealand: five in the genus *Psolus* Oken, and five in the genus *Psolidium* Ludwig. A key to the New Zealand and included Macquarie material is provided.

Keywords

Psolus, *Psolidium*, New Zealand, Macquarie Ridge, sea cucumber, Psolidae, new species, keys

Introduction

The most recent inventory of New Zealand Holothuroidea (Mah *et al.*, 2009) listed only three species in the family Psolidae Burmeister, 1837, and all were assigned to the genus *Psolus* Oken, 1815. One (*Psolus neozelanicus* Mortensen, 1925) was based on a single occurrence of a small specimen; another (*Psolus squamatus* (O.F. Müller, 1776)) was a known northern hemisphere species complex, and the third (*Psolus* ?n. sp.) remained unidentified. Examination of the considerable holdings of New Zealand's National Institute of Water and Atmosphere Ltd (NIWA) Invertebrate Collection (NIC) provided the opportunity to review the New Zealand psolid fauna. An overview of the Australian psolid holothuroids was recently published (Mackenzie and Whitfield, 2011); five new species were described and a comprehensive key to all 19 species now known in Australian and Macquarie waters was provided. This key was used as a basis for evaluation of the New Zealand psolid material and to assess the extent of overlap with the Australian fauna. Ten species in the genera *Psolus* and *Psolidium* were identified; five of them are described here, and for the remaining five species we provide new distribution records, comments on bathymetric and/or geographic range extensions, and diagnostic characters where required.

Of the six genera of the family Psolidae—*Ceto* Gistel, 1848, *Echinopsolus* Gutt, 1990, *Ekkentropelma* Pawson, 1971, *Lissothuria* Verrill, 1867, *Psolidium* Ludwig, 1886 and *Psolus* Oken, 1815—only two genera currently occur in New Zealand waters.

We are aware of the current invalid status of *Psolus* Oken, 1815 and use the genus name provisionally as we await the outcome of a request for validation by the International Commission for Zoological Nomenclature (Paulay and O'Loughlin, pers. comm.).

Methods

In order to extract the ossicles, the body wall tissue was dissolved in liquid household bleach. The extracted ossicles were studied by light microscopy (Nikon YS2-H) and by scanning electron microscopy (Philips XL30S FEG SEM). Clean ossicles for SEM examination were spread on a glass disk, air-dried and coated with platinum for 10 min. Photographs and measurements of the ossicles were taken. Specimen pictures were taken with a Nikon DX camera with a 60 mm macro lens. All specimens, including holotypes and paratypes, are registered in the NIC in Wellington. The internal anatomy is not systematically diagnostic and is not included in the new species descriptions.

In the following species descriptions, the station details are in the following format: the catalogue number NIWA XXXXX (number of specimens), voyage abbreviation and station number, latitude and longitude, depth, date of collection.

Abbreviations

CSIRO	Commonwealth Scientific and Industrial Research Organisation.
FRST	New Zealand Foundation for Research, Science and Technology.
KARMA	Kermadec Arc Minerals.
LINZ	Land Information New Zealand.
MBIE	New Zealand Ministry of Business, Innovation and Employment.
MPI	Ministry for Primary Industries (previously the New Zealand Ministry of Fisheries).
MV	Museum Victoria.
NIWA	National Institute of Water and Atmospheric Research Ltd, Wellington, New Zealand.
RV *Sonne*	Vessel used by IFM-GEOMAR Leibniz-Institut für Meereswissenschaften an der Universität Kiel and partners, and the interdisciplinary New Zealand–Australian 'MacRidge 2' research voyage.
RV *Tangaroa*	NIWA's research vessel.
SEM	Scanning electron microscopy.
TANXXXX/xx	RV *Tangaroa* research voyages (undertaken by NIWA) followed by year of the voyage, trip number and station number.
USNM	Smithsonian Institution National Museum of Natural History, Washington, DC, USA.

Key to New Zealand and Macquarie Ridge species of Psolidae Burmeister, 1837

1 Tube feet project through dorsal and lateral scales: ***Psolidium*** Ludwig, 1886 ..... **6**

– Tube feet absent dorsally: ***Psolus*** Oken, 1815 ..... **2**

2 Five symmetrical oral valves **3**

– Not with 5 symmetrical oral valves **4**

3 No encroachment of scales onto oral valves, no bowl ossicles ventrally ..... ***Psolus antarcticus*** (Philippi, 1857)

– Some encroaching of scales onto oral valves, bowl ossicles present ventrally ..... ***Psolus parantarcticus*** Mackenzie and Whitfield, 2011

4 More than 5 irregular oral valves. Conspicuous demarcation between dorsal scales and oral and anal valves. Macroscopic dome-like lumps on dorsal and lateral surface. Oral and anal opening conspicuous. Body wall does not contain cups **5**

– No distinct oral valves. No demarcation between dorsal scales and oral and anal valves. No macroscopic dome-like lumps on dorsal surface. Oral and anal opening inconspicuous. Body wall contains cups ..... ***Psolus macquariensis*** sp. nov

5 Profile low, smooth, domed. Anterior and anal openings not raised. Half-cylinders present in dorsal ossicles ..... ***Psolus salottii*** Mackenzie and Whitfield, 2011

– Profile not low, smooth, domed. Anterior and anal openings raised. No half-cylinders present in dorsal ossicles ..... ***Psolus squamatus*** (Müller, 1776) var. ***segregatus*** Perrier, 1905

6 Dorsal and lateral tube feet conspicuous macroscopically. Ventral ossicles thin-walled plates with 3–4 perforations, up to 125 μm long, 40 μm wide ..... ***Psolidium kermadeci*** sp. nov.

– Dorsal and lateral tube feet inconspicuous macroscopically. Ventral ossicles thick-walled plates **7**

7 Midventral row of tube feet. Dorsal and ventral ossicles contain branching rods (thorns) ..... ***Psolidium ramum*** sp. nov.

– No midventral row of tube feet. Dorsal and ventral ossicles do not contain branching rods (thorns) **8**

8 Less than 8 dorsal scales between oral and anal openings. Dorsal body wall appears rough. Largest specimen 16 mm total length. Tentacle trunk ossicles long, thick rods, sometimes perforated at ends or middle **9**

– More than 8 dorsal scales between oral and anal openings. Smooth appearance dorsally. Specimens often greater than 16 mm total length. Largest tentacle trunk ossicles predominantly plates with large irregular perforations ..... ***Psolidium whittakeri*** O'Loughlin and Ahearn, 2008

9 Ventral ossicles flat to slightly curved, single-layered, knobbed perforated plates with predominantly 4 (sometimes more) uniform perforations ..... ***Psolidium aequm*** sp. nov.

– Ventral ossicles flat to slightly curved, single-layered, knobbed perforated plates with 2 large central perforations and numerous smaller marginal perforations ..... ***Psolidium marriotti*** sp. nov.

Order **Dendrochirotida** Grube, 1840 (restricted Pawson and Fell, 1965)

Family **Psolidae** Burmeister, 1837

Diagnosis. (See O'Loughlin and Maric, 2008). Body flattened, with well-defined ventral sole. Dorsal surface invested by imbricating scales. Ventral sole soft, surrounded by tube feet. Mouth and anus dorsally upturned.

Remarks. For synonymies, discussion, and a key to genera of Psolidae see O'Loughlin and Maric (2008) together with the amendments listed in O'Loughlin and Whitfield (2010) and Mackenzie and Whitfield (2011). There is a key to the Australian species of Psolidae in Mackenzie and Whitfield (2011), reflected in the key provided here.

Type genus. Psolus Oken, 1815 (original description; *Lepidopsolus* Bronn, 1860, and *Lophothuria* Verrill, 1867; synonymy by Théel, 1886).

Genus ***Psolus*** Oken, 1815

Diagnosis. (O'Loughlin and Whitfield 2010). Psolidae with large imbricating or contiguous dorsal and lateral scales; ventrolateral scales at margin clearly demarcated from thin sole that lacks conspicuous scales. Tube feet absent dorsally and laterally, sometimes present orally and anally.

Psolus antarcticus (Philippi, 1857)

Table 1, Figures 1, 3A–C

Holothuria antarctica Philippi, 1857: 133.

Psolus antarcticus Ludwig, 1898: 53, pl. 3-figs 34–36 (complete synonymy).—Ekman, 1923: 42, figs 31–33; 1925: 139, text-fig. 34.—Deichmann, 1947: 339.—Pawson, 1968a: 19, fig. 2 (1–4).—Mackenzie and Whitfield, 2011: 26–28.

Psolus neozelanicus Mortensen, 1925: 362, figs 44–45.—Dawbin, 1950: 35, pl. 1-fig. 2.—Pawson, 1970: 28.—Mah *et al.*, 2009: 398.—Mackenzie and Whitfield, 2011: 28.

Material examined. Macquarie Ridge: NIWA 40954 (2) Stn TAN0803/93, 56.25°S 158.51°E, 676–750 m, 16/04/2008; NIWA 40887 (16) Stn TAN0803/94, 55.37°S 158.38°E, 501–577 m, 15/04/2008; NIWA 40758 (9) Stn TAN0803/91, 55.36°S 158.42°E, 501–630 m, 15/04/2008; NIWA 40824 (1) Stn TAN0803/93, 55.35°S 158.43°E, 605–709 m, 15/04/2008; NIWA 40853 (1) Stn TAN0803/94, 55.37°S 158.38°E, 501–577 m, 15/04/2008; NIWA 68127 (1) Stn E227, 54.68°S 158.91°E, 148 m, 24/02/1965; NIWA 76248 (1) Stn C734, 53.91°S 158.91°E, 360 m, 25/11/1961. New Zealand, Hikurangi Margin: NIWA 65685 (8) Stn F767, 41.51°S 176.11°E, 1205 m, 21/08/1966; NIWA 63356 (1) Stn TAN1004/36, 41.59°S 175.85°E, 1150–1177 m, 18/04/2010; NIWA 63906 (9) Stn TAN1004/100, 42.13°S 174.54°E, 1375–1480 m, 24/04/2010; NIWA 71936 (19) Stn G954, 42.61°S 175.97°E, 1190 m, 02/06/1973. New Zealand, Chatham Rise: NIWA 30627 (2) Stn TAN0705/94, 44.56°S 178.4°E, 1110–1119 m, 10/04/2007; NIWA 30629 (1) Stn TAN0705/98, 44.56°S 178.4°W, 1074–1081 m, 10/04/2007; NIWA 30630 (8) Stn TAN0705/98, 44.56°S 178.4°W, 1074–1081 m, 10/04/2007; NIWA 63968 (2) Stn Z10820, 41.59°S 175.77°E, 1400 m, 26/05/2001; NIWA 63931 (1) Stn TAN1004/103, 42.13°S 174.53°E, 1169–1213 m, 25/04/2010; NIWA 71146 (1) Stn 2253/20, 44.7°S 176.6°E, 794–1156 m, 29/05/2006; NIWA 76355 (1) Stn S1065H, 44.14°S 178.5°E, 990 m, 05/05/1997.

Description. See Mackenzie and Whitfield (2011) for the most recent description of this species including photos of the ossicles. All material examined here concurs with this recent description and any variations or amendments are discussed below.

Colour. Preserved: white and pale brown; dorsal and lateral scales have pale brown centres with a white periphery. This differs from Mackenzie and Whitfield (2011), in which specimens examined were white only.

Distribution. Previously reported from South America (Magellanic region), South Georgia, Macquarie Island, 100–1666 m; extended here to New Zealand and further locations along Macquarie Ridge, 360–1480 m.

Remarks. Mackenzie and Whitfield (2011) recently confirmed the distribution of *Psolus antarcticus* (Philippi, 1857) as extending into Australian and Macquarie Island waters. Herein, we confirm that *P. antarcticus* is known from the continental

Table 1. Distribution of New Zealand and Macquarie Ridge species of Psolidae Burmeister, 1837.

Species	Distribution **(new records are provided in bold)**	Depth range **(new records are provided in bold)**
***Psolus* species**		
Psolus antarcticus (Philippi, 1857)	Magellanic region of South America; South Georgia; Macquarie Island; **New Zealand; Macquarie Ridge**	100–1666 m
Psolus macquariensis **sp. nov.**	**Macquarie Ridge**	**398–489 m**
Psolus parantarcticus Mackenzie and Whitfield, 2011	Australia, Macquarie Island; **New Zealand, Hikurangi Margin; Macquarie Ridge**	108–135 m **104–1053 m**
Psolus salottii Mackenzie and Whitfield, 2011	South Australia; Macquarie Ridge	400–820 m
Psolus squamatus (Müller, 1776) var. *segregatus* Perrier, 1905	South America, Straits of Magellan and Argentina; **New Zealand, Hikurangi Margin, Chatham Rise**	**320–468 m, 817 m**
***Psolidium* species**		
Psolidium aequm **sp. nov.**	**New Zealand, Hikurangi Margin**	**1040–1059 m**
Psolidium kermadeci **sp. nov.**	**New Zealand, Kermadec Trench**	**1380–1545 m**
Psolidium marriotti **sp. nov.**	**New Zealand, Hikurangi Margin, Chatham Rise, North Cape; Macquarie Ridge**	**136–885 m**
Psolidium ramum **sp. nov.**	**New Zealand, North Island west coast canyons**	**188–210 m**
Psolidium whittakeri O'Loughlin and Ahearn, 2008	Antarctica; South Sandwich Island; South Shetland Island; Bouvet Island; **New Zealand**	146–759 m, **443–503 m**

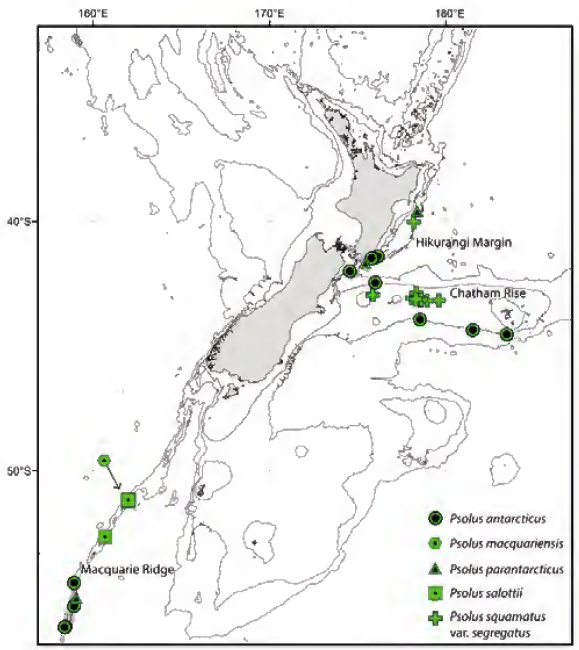

Figure 1. Map of area showing station locations of *Psolus* species in the New Zealand and Macquarie Ridge regions.

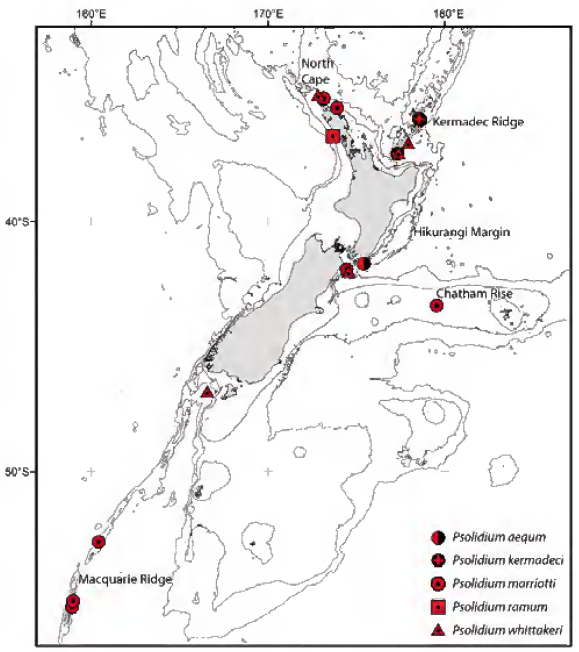

Figure 2. Map of area showing station locations of *Psolidium* species in the New Zealand and Macquarie Ridge regions.

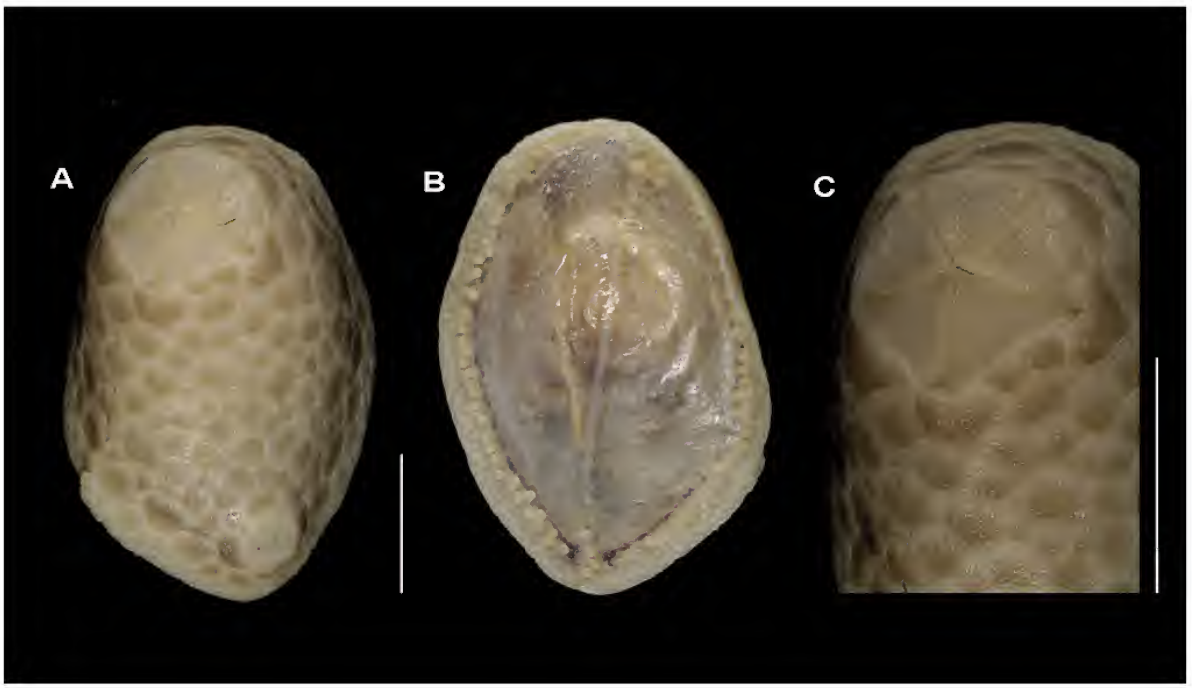

Figure 3. *Psolus antarcticus* (Philippi, 1857) (A–C, NIWA 30627): A, dorsal view; B, ventral view; C, close up of 5 even oral valves with no scale encroachment. Scale bar 1 cm.

slope around New Zealand, including the Chatham Rise. The specimens examined here morphologically match the type description, however, we do note that the colour of this relatively fresh material has brown scale centres compared with the uniform white colour previously reported. The depth distribution of the New Zealand material is within the known range of 100–1666 m.

Psolus neozelanicus Mortensen, 1925 was based on two small specimens from east of North Cape, New Zealand. It has not been collected since. This species was briefly discussed in Mackenzie and Whitfield (2011). We further judge from the type description of its knobbed perforated plates (four central perforations recognisable) and five symmetrical valves that this species is a subjective junior synonym of *Psolus antarcticus*. Mortensen (1925) discusses the ventral ossicles with four central perforations, which are well known in *P. antarcticus*. His illustrations (p. 363), however, tend to show ossicles with slightly more numerous perforations that are present dorsally, rather than ventrally. We re-examined some of our smaller (7–9 mm) *P. antarcticus* specimens (NIWA 40758) and found the ventral ossicles predominantly with four, but sometimes with up to six perforations like the larger *P. antarcticus*. Ventral ossicles were sparse in both of our small specimens. All specimens previously identified as *P. neozelanicus* in both the NIC and Museum of Victoria (MV) have been re-examined and determined to be *P. antarcticus* or *P. parantarcticus* Mackenzie and Whitfield, 2011.

Psolus macquariensis sp. nov.

http://zoobank.org/urn:lsid:zoobank.org:act:B0AC4334-A7DF-4548-B5DB-D33715DB5A09

Table 1, Figures 1, 4A–C, 7A–F

Material examined. Holotype. Macquarie Ridge: NIWA 40314 (1) Stn TAN0803/69, 52.39°S 160.65°E, 438–451 m, 09/04/2008.

Paratypes. NIWA 68135 (2) same locality data as holotype.

Other material. Macquarie Ridge: NIWA 40050 (1) Stn TAN0803/53, 51.04°S 162.01°E, 398–489 m, 05/04/2008; NIWA 40326 (2) Stn TAN0803/69, 52.39°S 160.65°E, 438–451 m, 09/04/2008.

Description. *Psolus* species up to 16 mm long, 6 mm high, 5 mm wide. Body form oval, low profile, body wall thin and soft. Oral and anal openings inconspicuous with no distinctive valves.

Dorsal and lateral scales inconspicuous, glassy bead-like texture, up to 800 μm diameter, decreasing in size towards lateral edge. Sole elongate oval, thin walled, slight anterior taper. Tube feet on sole periphery in 2 rows; inner series close together, continuous, terminal disc up to 400 μm diameter; outer series smaller, terminal disc up to 250 μm diameter, sparsely arranged, not complete. Midventral single row of scattered tube feet, which can be long with terminal discs on ends of extended stalks, some extending over the sole margin.

Dorsal and lateral ossicles single-layered perforated plates (scales), some with secondary thickening and ribbing towards centre of plates, up to 810 μm wide; cups up to 45 μm long, 30 μm deep with a cross-type base, knobbed edges. Ventral ossicles single-layered, smooth perforated plates up to 150 μm long, sparse cups up to 65 μm long. Tentacle ossicles single-layered perforated plates only, up to 230 μm long.

Colour. Preserved: white.

Distribution. Macquarie Ridge, 398–489 m.

Etymology. Named after the type locality, Macquarie Island.

Remarks. *Psolus macquariensis* sp. nov. is closest to southern Australian species *Psolus steuarti* Mackenzie and Whitfield, 2011, with its similar granulated scales dorsally and laterally, and cups in the dorsal body wall. *P. macquariensis* sp. nov. differs from *P. steuarti* in the presence of midventral tube feet and in the dorsal and lateral ossicles consisting of only single-layered plates. Also, in *P. macquariensis* sp. nov., ventral ossicles are smooth perforated plates, while *P. steuarti* has knobbed plates.

Psolus parantarcticus Mackenzie and Whitfield, 2011

Table 1, Figure 1

Material examined. New Zealand, Hikurangi Margin: NIWA 68125 (1) Stn TAN0616/83, 41.78°S 175.39°E, 1053–1050 m, 13/11/2006; NIWA 68128 (1) Stn TAN0616/79, 41.78°S 175.39°E, 1040–1053 m, 13/11/2006. Macquarie Ridge, NIWA 76249 (1) Stn C733, 54.41°S 159.03°E, 104 m, 25/11/1961.

Description. See Mackenzie and Whitfield (2011). All specimens examined concur with this description unless discussed below.

Colour. Preserved: white (Mackenzie and Whitfield, 2011), although in present material dorsal and lateral scales have some pale brown markings.

Distribution. Australia, Macquarie Island, 108–135 m (Mackenzie and Whitfield, 2011). New Zealand and Macquarie Ridge, 1052 m (this study).

Remarks. *Psolus parantarcticus* Mackenzie and Whitfield 2011 was first described from Macquarie Island. We subsequently found two more specimens of this species in our New Zealand and Macquarie Ridge material. The encroaching valves, ventral bowl-shaped ossicles, and multilayered dorsolateral ossicles are distinctive morphological features that clearly differentiate this species from *P. antarcticus*. This study significantly extends the known depth range for *P. parantarcticus* from 135 to 1052 m.

Psolus salottii Mackenzie and Whitfield, 2011

Table 1, Figure 1

Material examined. Macquarie Ridge: NIWA 39894 (1) Stn TAN0803/48, 51.09°S 161.97°E, 462–524 m, 04/04/2008; NIWA 39928 (2) Stn TAN0803/48, 51.09°S 161.97°E, 462–524 m, 04/04/2008; NIWA 39979 (3) Stn TAN0803/52, 51.04°S 161.98°E, 506–560 m, 04/04/2008; NIWA 39993 (4) Stn TAN0803/52, 51.04°S 161.98°E, 506–560 m, 04/04/2008; NIWA 40010 (3) Stn TAN0803/52, 51.04°S 161.98°E, 506–560 m, 04/04/2008; NIWA 40047 (1) Stn TAN0803/53, 51.04°S 162.01°E, 398–489 m, 05/04/2008; NIWA 40355 (18) Stn TAN0803/71, 52.34°S 160.68°E, 488–542 m, 09/04/2008; NIWA 40396 (14) Stn TAN0803/71, 52.34°S 160.68°E, 488–542 m, 09/04/2008.

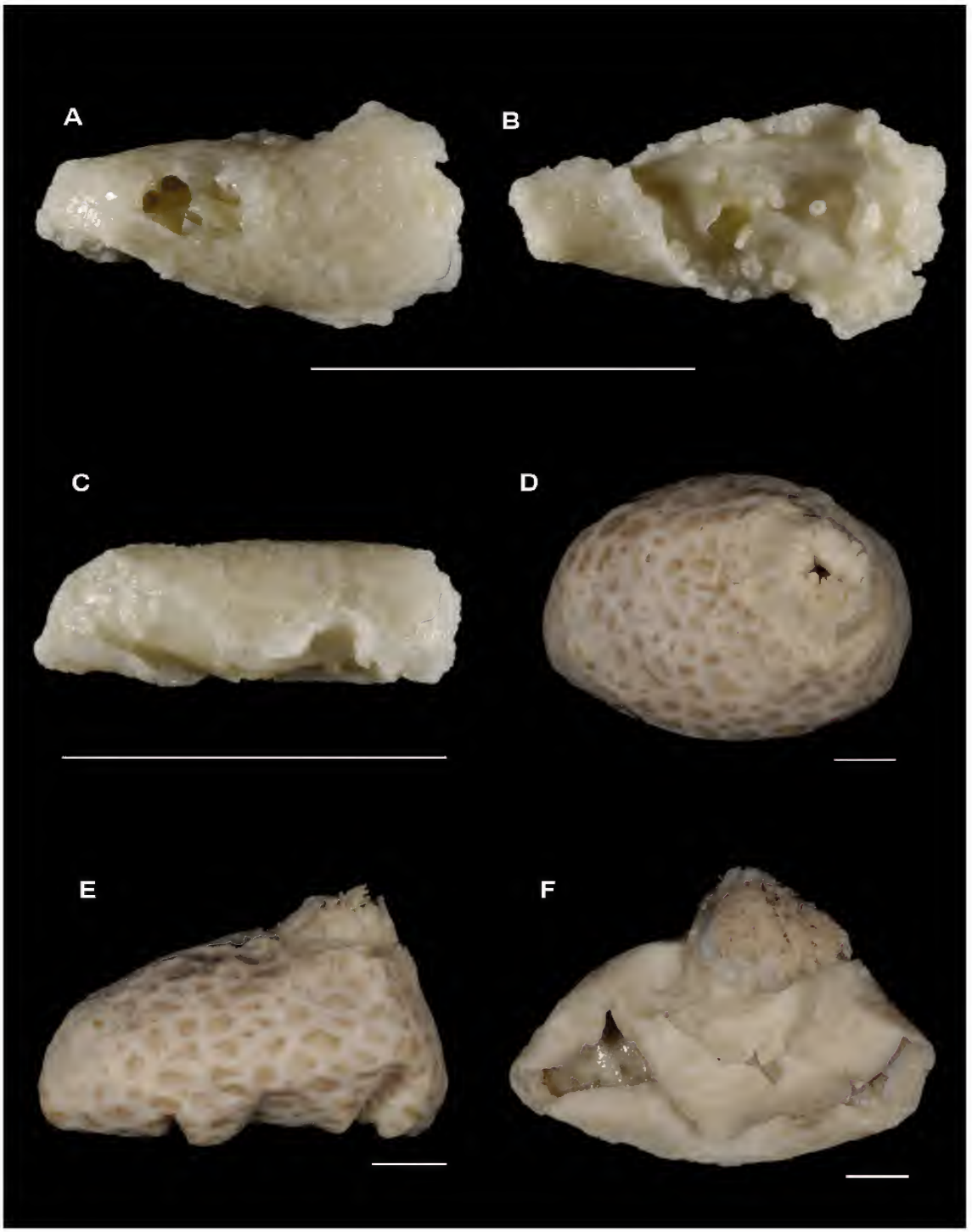

Figure 4. *Psolus macquariensis* sp. nov. paratype (A–C, NIWA 40314): A, dorsal view; B, ventral view showing some extended tube feet; C, lateral view. *Psolus squamatus* (Müller, 1776) var. *segregatus* Perrier, 1905 (D–E, NIWA 43709): D, dorsal view; E, lateral view. *Psolus squamatus* (Müller, 1776) var. *segregatus* Perrier, 1905 (F, NIWA 43714): lateral view of specimen with numerous sole ossicles. Scale bar 1 cm.

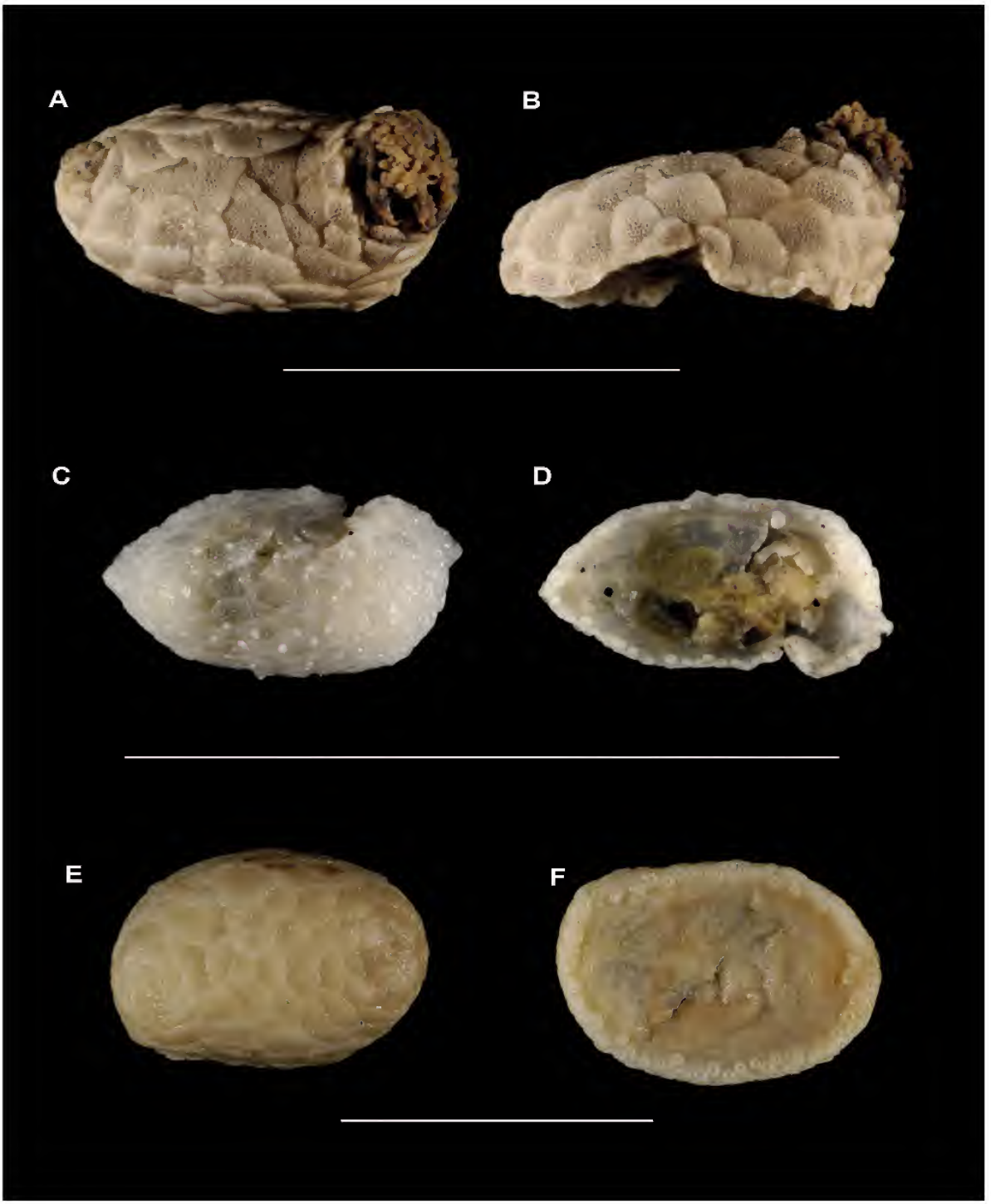

Figure 5. *Psolidium aequm* sp. nov. (A–B, NIWA 32259): A, dorsal view; B, lateral view. *Psolidium kermadeci* sp. nov. paratype (C–D, NIWA 64441): C, dorsal view showing conspicuous tube feet; D, ventral view. *Psolidium marriotti* sp. nov. paratype (E–F, NIWA 76126): E, dorsal view; F, ventral view. Scale bar 1 cm.

Figure 6. *Psolidium ramum* sp. nov. holotype (A–B, NIWA 73660): A, dorsal view; B, ventral view. Scale bar 1 cm.

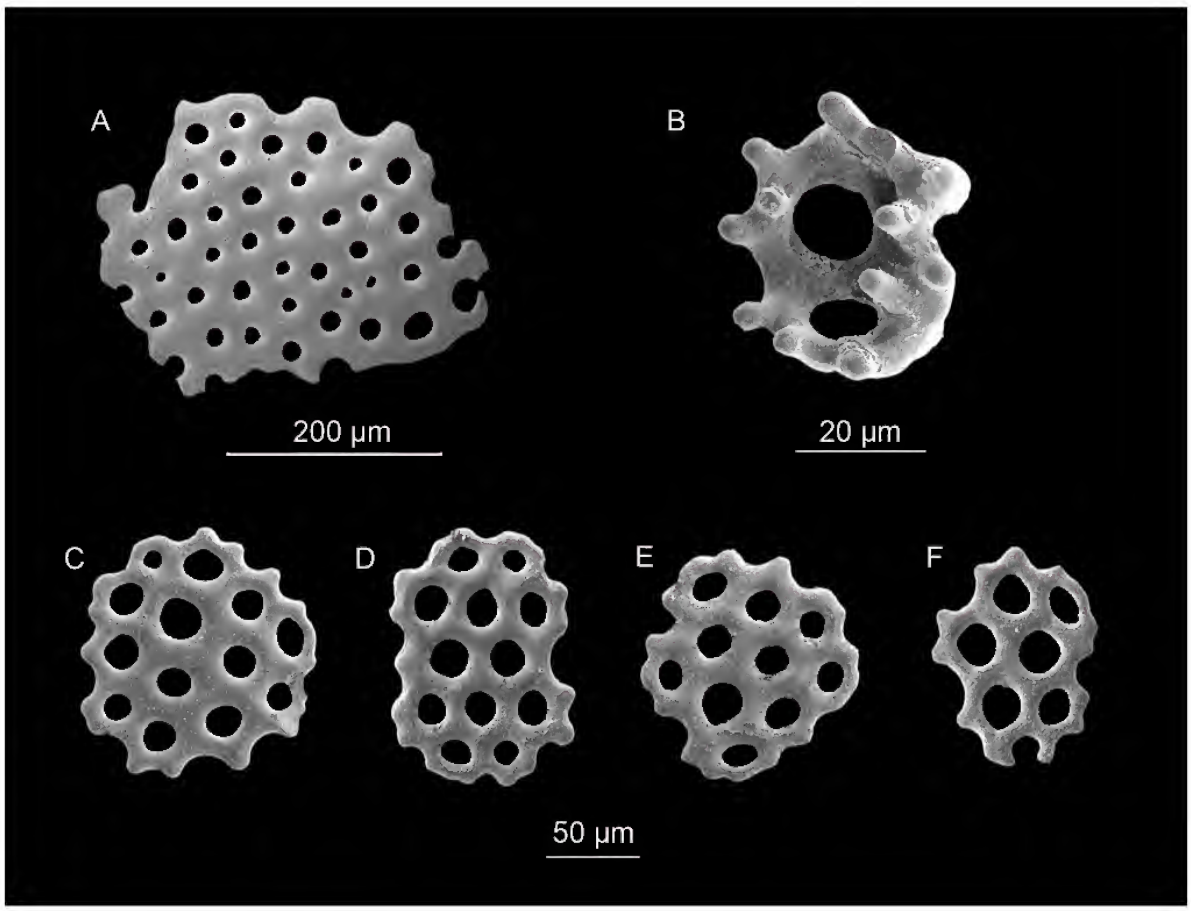

Figure 7. *Psolus macquariensis* sp. nov. paratype (A–F, NIWA 40314): A–B, dorsal single-layered plate, dorsal cup; C–F, ventral ossicles, smooth perforated plates.

Description. See Whitfield and Mackenzie (2011). The material examined matches the description well, and we make the following additions: *Psolus salottii* Whitfield and Mackenzie, 2011, up to 71 mm length (NIWA 40355), 54 mm wide, 29 mm high. Oral valves large and inconsistent in shape, ranging from rectangular with blunt ends to approximately triangular with pointed tips. Valves usually 10; always greater than 5.

Colour. Preserved: white.

Distribution. South Australia, Macquarie Ridge (Whitfield and Mackenzie, 2011) and this paper, 400–600 m.

Remarks. The original description was based on one holotype specimen from southern Australia and four paratypes from Macquarie Island. We found an additional 46 specimens, confirming and extending the Whitfield and Mackenzie (2011) description. The dome-like lumps on the dorsolateral scales are not always visible, and they may only be on a few scales. The multilayered ossicles in the preparation are always distinctly dome-like and provide a useful diagnostic character for this species.

Psolus squamatus (Müller, 1776) **var. *segregatus*** Perrier, 1905

Table 1, Figure 1, 4D–F

Psolus squamatus, Düben and Koren, 1846 (var. ?).—Théel, 1886: 89–90, pl. 15-figs 1–2, pl. 6-fig. 2.

Psolus antarcticus.—Ludwig, 1894: 98 (in note) (part).

Psolus pauper Ludwig, 1894. (Synonymy in Deichmann, 1941.)

Psolus squamatus.—H.L. Clark, 1901: 165; 1901: 491. (Synonymy in Deichmann, 1941; non-*Psolus squamatus* (O.F. Müller, 1776).)

Psolus squamatus var. *segregatus* Perrier, 1905: 59–65.

Psolus segregatus.—Vaney, 1906: 26–30, pl. 1-figs 14–15, pl. 2-figs 19–20.

Psolus squamatus (O.F. Müller, Koren) var. *segregatus* Perrier, 1905.—Ekman, 1923: 1–59, 37 text-figs.—Ekman, 1925: 136–139, fig. 33.

Psolus squamatus (Koren) var. *segregatus* Perrier.—Deichmann, 1941: 147–148, pl. 30-fig. 7.

Psolus squamatus (Koren, 1845).—Pawson, 1969: 129 (not *Psolus squamatus* (O.F. Müller, 1776)).

Psolus aff. *squamatus* (O.F. Müller, 1776).—Massin and Hendrickx, 2011: 419–420.

Material examined. New Zealand, Chatham Rise: NIWA 27619 (2) Stn TAN0701/14, 43.35°S 179.58°E, 409–423 m, 31/12/2006; NIWA 43709 (1) Stn TAN0801/4, 43.26°S 178.05°E, 320–339 m, 28/12/2007; NIWA 43714 (1) Stn TAN0801/37, 44.22°S 179.1°E, 484–492 m, 03/01/2008; NIWA 44805 (5) Stn TAN0501/90, 43.36°S 178.53°E, 371–384 m, 14/01/2005; NIWA 49919 (1) Stn TAN0301/64, 43.92°S 179.7°W, 405–420 m, 10/01/2003; NIWA 76127 (8) Stn TAN0201/20, 43.28°S 178.27°E, 348–358 m, 01/01/2002; NIWA 76128 (1) Stn Z10972, 43.12°S 175.81°E, 467 m, 04/09/2001; NIWA 76129 (4) Stn Z10931, 43.13°S 175.83°E, 441 m, 30/10/2001; NIWA 76130 (4) Stn Z10929, 43.12°S 175.81°E, 467 m, 4/09/2001; NIWA 76131 (27) Stn Z9618, 43.36°S 178.91°E, 393 m, 04/01/1999; NIWA 76132 (6) Stn Z10829, 43.26°S 178.42°E, 374 m, 30/12/2000; NIWA 76133 (2) Stn Z10585, 43.05°S 178.29°E, 341 m, 30/12/2000; NIWA 76134 (1) Stn Z10583, 43.32°S 178.56°E, 398.0 m, 12/01/2001; NIWA 76424 (2) Stn TAN0601/10, 43.31°S 178.26°E, 324–340 m, 29/12/2005.

Description. Follows Perrier (1905) and Ekman (1923) with additional details based on the specimens examined. *Psolus* species up to 61 mm long, 30 mm high, 39 mm wide. Body form oval, mid- to high-domed profile with raised oral and anal valves, higher anteriorly. Oral opening surrounded by 7–12 long, irregular, triangular to oblong oral plates or plate fragments, inconsistent in shape and number, imbricating slightly, thickly calcareous, granular surface, demarcation between body scales and oral plates variable, usually some body scales encroaching at base of oral plates. Anal opening a series of small scales continuous with dorsal and lateral scales, no distinct plates, heavily imbricating in circular formation surrounding the anus.

Dorsal and lateral scales predominantly 3–5 mm wide, a few up to 12 mm wide, but decreasing in size towards anal and oral valves and at lateral edge, macroscopically evident, scales imbricate slightly; scale margin colouration consistently light (white or cream), usually with a brown centre, variable in intensity, can appear spotty; scales with coarsely granular surface, granules loose or attached, globular, up to 310 μm wide. Sole oval, without tapering anally or orally; inner series of tube feet arranged in 1–3 rows around the outer sole perimeter, crowded, can extend midventrally posteriorly and anteriorly; outer peripheral series of smaller tube feet in a spaced, single row, close to the ventral margin; midventral series of tube feet variably present, extending anteriorly or posteriorly only, or absent completely.

Dorsal and lateral ossicles mainly large multilayered plates covered in granules, as described above; some thickened plates up to 180 μm long; rare smooth perforated plates up to 130 μm long; rare single-layered plates with secondary layering in some specimens. Ventral ossicles perforated plates ranging from simple crosses without complete perforations to some with up to 15 perforations.

Colour. Preserved. Directly into ethanol: oral, anal valves and sole white; dorsal scales centrally graduating brown to cream, white on perimeter. Frozen then ethanol: cream scales, white plates, no brown centres (NIWA 43714, NIWA 44805).

Distribution. South America, Strait of Magellan and Argentina, 256–274 m. Extended to New Zealand, Chatham Rise, 320–492 m here.

Remarks. The majority of the New Zealand material fits the description above, but there is variability in the number and appearance of the ventral ossicles. The variability ranges from a complete absence of ossicles (majority of specimens) to specimens with rare broken pieces of single-layered, smooth perforated plates (0–3 perforations, NIWA 76130, NIWA 76127, NIWA 76128) and two specimens (NIWA 43714, NIWA 44805) yielding smooth perforated plates and rare broken pieces. These plates variably have marginal projections, low knobs, and can be flat to slightly concave.

Théel (1886), Ludwig (1894), Perrier (1905) and Vaney (1906) all tried but failed to find a diagnostic difference between the North Atlantic and southern American specimens of *Psolus squamatus* (O.F. Müller, 1776), but the opinion was shared that a bipolar species was unlikely, and accordingly Perrier (1905) erected the variety *segregatus* for the southern form. Ekman (1923) presented an exhaustive comparison of Norwegian and South American specimens and confirmed the status of the variety *Psolus squamatus* (Müller, 1776) var.

segregatus Perrier, 1905. In particular Ekman (1923) recognised the significant size difference in the dorsal and lateral surface granules. Deichmann (1941) and Massin and Hendrickx (2011) accepted the status of the variety. Pawson (1969) determined specimens from Chile to be *P. squamatus* and did not accept the distinct species or variety status.

O'Loughlin (pers. comm.) examined specimens in the Smithsonian Institution that were identified as *Psolus squamatus* (Müller, 1776), from Norway (USNM 8583), the West European Basin (USNM E38321), and Alaska (USNM 24536, USNM E27846). He concluded that there are two species represented and neither is conspecific with the Californian specimens (USNM E17011, USNM E16931), which are in turn not conspecific with southern American specimens from the Strait of Magellan (USNM E33632, USNM E33634, USNM E33635) and Argentina (USNM 22201). A useful character for distinguishing between the different putative species in this complex may be the presence or absence and size of surface granules. The species most similar to *P. squamatus* that range in their distribution from the North Atlantic and into the Pacific along the western coast of the Americas from Alaska to Cape Horn are united by the presence of larger surface granules. Overall, the dorsal surface loose granule size, and the sole ossicle perforations and sizes are the major differences between *P. squamatus* and *P. squamatus* var. *segregatus*. *Psolus squamatus* var. *segregatus* sole ossicles are perforated plates that are smaller (75–110 μm) compared with those of *P. squamatus* (150–300 μm).

The status of both the species and the variety is undergoing an extensive systematic review (Martinez, pers. comm.). Until this is complete, our New Zealand species is designated as *P. squamatus* var. *segregatus*, but with minor reservation. The largest ossicles we found (in only two specimens) ranged from 95–140 μm long, but never reached the size documented for *Psolus squamatus*. Also, the size of the dorsal granules for *P. squamatus* var. *segregatus* is documented at 330–470 μm compared with 150–250 μm in *P. squamatus*. Our New Zealand specimen's dorsal granules were variable in size, but the loose ones were measured as predominantly 270–350 μm, with only a few larger ones variably present (up to 500 μm). Our minor reservation is the frequent absence of ossicles in the sole in our New Zealand specimens. Deichmann (1941), when discussing the variety, notes that the ossicles often disappear with age. Ossicles were predominantly absent in large specimens, hence our decision to place these New Zealand specimens in *P. squamatus* var. *segregatus*. All these examined specimens come from similar locations and depths and are of comparable sizes.

Genus ***Psolidium*** Ludwig, 1886

Diagnosis. (After O'Loughlin and Maric, 2008). Dendrochirotid holothuroids; small, up to 40 mm long; midbody arched dorsally in transverse section, flat ventrally; dorsal and lateral body covered with imbricating scales, usually macroscopically conspicuous, sometimes obscured by integument, scales irregular in size and arrangement; scales decreasing in size ventrolaterally, orally and anally; lacking large oral valves; extensible oral cone with anterior, anterior–dorsal or dorsal orientation; extensible anal cone with posterior, posterior–dorsal or dorsal orientation; tube feet dorsally and laterally in midbody, passing through scales.

Sole distinct, oval to elongate; discrete margin created by junction of small imbricating ventrolateral scales, with thin-walled, usually calcareous sole that lacks scales; peripheral band of tube feet, may be discontinuous across the interradii anteriorly and posteriorly; peripheral tube feet frequently of 2 sizes, those of outer series smaller; midventral radial series of tube feet present or absent.

Calcareous ring solid, plates subrectangular, radial and interradial plates with tapered anterior projections; radial plates with deep notch posteriorly, interradial plates with shallow concave indentation posteriorly; 10 dendritic tentacles, ventral 2 smaller.

Dorsal and lateral ossicles: multilayered or single-layered perforated plates (scales), always some with tube foot canals; integument covering scales may have cupped crosses, cups, 'thorn' ossicles (irregular branched rods pointed distally), buttons, perforated plates and rosettes; tube foot small endplates, and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Sole ossicles: interradii with small to large single-layered perforated plates (rarely with multilayering), smooth to variably knobbed and thickened, sometimes with cupped crosses, cups, thorn ossicles and rosettes; radii with additional tube foot ossicles, large endplates and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Psolidium aequm sp. nov.

http://zoobank.org/urn:lsid:zoobank.org:act:3EC47623-6ED4-442B-887C-C4454A26A2A1

Table 1, Figures 2, 5A–B, 8A–H.

Material examined. Holotype. New Zealand, Hikurangi Margin: NIWA 68136 (1) Stn SO191-2/138, 41.78°S 175.40°E, 1043–1059 m, RV *Sonne*, 18/02/2007.

Paratypes. NIWA 32023 (29), same as holotype locality and date.

Other material. Hikurangi Margin: NIWA 26413 (8) Stn TAN0616/79, 41.78°S 175.39°E, 1040–1053 m, 13/11/2006; NIWA 26414 (7) Stn TAN0616/83, 41.78°S 175.39°E, 1050–1053 m, 13/11/2006; NIWA 32259 (37) Stn SO191-2/149, 41.78°S 175.40°E, 1055 m, 19/02/2007; NIWA 34955 (9) Stn TAN0616/79, 41.78°S 175.39°E, 1040–1053 m, 13/11/2006.

Description. Psolidium species up to 10 mm long, 5.5 mm wide, 5 mm high. Profile moderately low, anal and oral ends commonly raised, no discrete oral or anal valves or plates. Dorsal and lateral scales continuous over body wall, up to 1.5 mm wide, decreasing in size towards the ventral sole. Scales orally and anally smaller, less granular than other scales and paler in colour; dorsal and lateral scales brown, with a 0.25 mm pale grey to white margin; scales on ventral margin up to 0.5 mm wide and lighter in colour, imbricate. Dorsal and lateral tube feet small, inconspicuous, few visible. Tentacles 10, 8 + 2 (ventral smaller). Sole naked midventrally, peripheral series of closely set large tube feet in a single row, sometimes extending

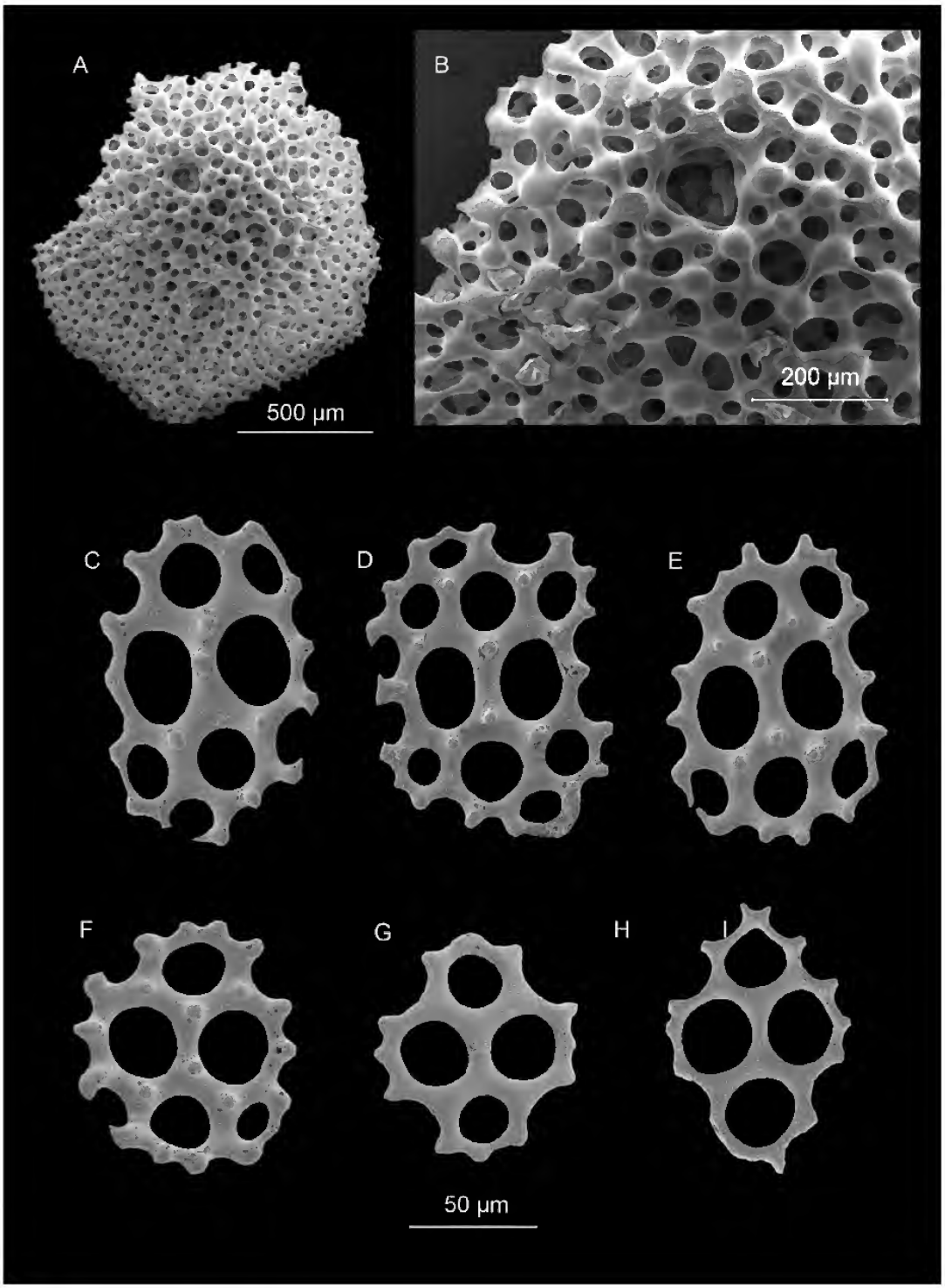

Figure 8. *Psolidium aequm* sp. nov. paratype (A–H, NIWA 32023): A–B, dorsal scales with tube feet holes visible; C–H, ventral ossicles, knobbed plates with 4 uniform central perforations.

onto midventral radius anteriorly and posteriorly; no complete outer series of small peripheral tube feet but on some specimens few smaller tube feet scattered around ventral margin.

Dorsal and lateral ossicles large multilayered perforated plates (scales) with tube feet holes, sometimes with marginal thickening, secondary layering and anastomosing towards outer margins, up to 1580 μm wide with small inconspicuous tube foot canals up to 45 μm wide; large thick, single-layered plates up to 120 μm long with a smooth surface; tube foot support plates thin, rare (due to few dorsal or lateral tube feet) single-layered plates, curved, variably smooth or finely knobbed and relatively curved, up to 80 μm long and with up to 8 perforations. Ventral ossicles flat to slightly curved single-layered perforated plates up to 125 μm long, one side of plates knobbed, other side completely smooth, commonly with 4 perforations (up to 13). Perforations mostly uniform in size but sometimes a few smaller marginal perforations present; margin of plates sharp and angular. Tentacle ossicles long, thick rods, sometimes perforated at either end, less commonly perforated in the middle, rods up to 300 μm long, variable in shape, from straight to curved, rarely with a 'bend' centrally but most commonly with a slight curve, blunt spines sometimes present on either side of centre, sometimes a cluster of perforations at the end of a rod. Smaller single-layered perforated plates, up to 80 μm long, perforations inconsistent in size, shape and arrangement, ranging from flat to curved.

Colour. Preserved: pale to dark brown with grey, light brown or white margins around dorsal and lateral scales. Tentacles brown.

Distribution. New Zealand, Hikurangi Margin, 1040–1059 m.

Etymology. The species name is Latin, meaning equal, to reflect the characteristic regular perforations in the ventral ossicles.

Remarks. *Psolidium aequm* sp. nov. differs from other *Psolidium* species by a combination of the ventral ossicles having predominantly four (sometimes more) uniform perforations, the presence of a few outer ventral peripheral tube feet, the presence of tentacle rod ossicles, commonly with perforations through the middle as well as blunt spines on either side of the middle.

Psolidium kermadeci sp. nov.

http://zoobank.org/urn:lsid:zoobank.org:act:883E2AAC-C79C-4145-9656-D41C50DA6A77

Table 1, Figures 2, 5C–D, 9A–D

Material examined. Holotype. New Zealand, Kermadec Trench: NIWA 72333 (1) Stn TAN0411/32, 35.36°S 178.52°E, 1425–1440 m, 07/03/2011.

Paratype. New Zealand, Kermadec Trench, NIWA 64441 (1) Stn TAN1007/51, 35.42°S 178.62°E, 1380–1545 m, 01/06/2010.

Other material. Kermadec Trench: NIWA 49868 (1) Stn TAN0413/40, 36.96°S 177.29°E, 1652 m, 09/11/2004.

Description. *Psolidium* species up to 10 mm long, 4 mm wide, 3 mm high (preserved). Body form oval, profile dome-like with slightly raised oral and anal cones. Body wall scales macroscopically evident and continuous over domed dorsal and lateral surface, including oral and anal cones, largest scales up to 575 μm wide and 414 μm high, scale appearance glassy, beady, overall smooth, lacking any bumps or pillars. No discrete oral or anal valves or plates present, scales surrounding oral and anal cones reduced. Conspicuous dorsal tube feet evident, ranging from radial axis presence only through to several tube feet continuous onto interradials. Tentacles 10, 8 + 2 (ventral smaller). Sole distinct, calcareous, peripheral single row of tube feet, no smaller outer row, no midventral tube feet.

Dorsal ossicles are single-layered perforated scales, centrally some anastomosing, with tube feet holes evident, curved perforated support plates up to 55 μm wide. Ventral ossicles are thin-walled perforated plates with tiny blunt knobs, 3–4 perforations predominant, up to 125 μm long, perforations up to 40 μm wide.

Colour. Preserved: white.

Distribution. New Zealand, Kermadec Trench, 1380–1545 m.

Etymology. Named after Huon de Kermadec, an 18th century French navigator after whom the Kermadec islands were named, and eventually the Kermadec Trench, where the specimens were found.

Remarks. This description is based on two small specimens found in relatively close proximity to each other, at similar depths (>1000 m). This is the first record of a *Psolidium* from the Kermadec Trench. *Psolidium kermadeci* sp. nov. is closest to the southern Australian species *Psolidium granuliferum* (Clark, 1938), but differs in possessing conspicuous tube feet dorsal and laterally. Also, like all other Australian *Psolidium* species, *P. granuliferum* is found in shallow depths, whereas *P. kermadeci* is one of the deepest occurring *Psolidium* species in the South Pacific region. This species also differs from the other New Zealand *Psolidium* species described in this paper as the dorsal tube feet are conspicuous and projecting through the body wall scales, whereas the other new *Psolidium* species require microscopic investigations to determine if such tube feet are present. Additionally, the sole ossicles are much thinner, have fewer perforations, and carry spinous knobs marginally.

Psolidium marriotti sp. nov.

http://zoobank.org/urn:lsid:zoobank.org:act:EBEB19BA-C15D-448A-86B8-EFBCF894E9FF

Table 1, Figures 2, 5E–F, 10A–E

Material examined. Holotype. New Zealand, Chatham Rise: NIWA 68137 (1) Stn N857, 43.54°S 179.54°E, 399 m, 17/12/1976.

Paratypes. NIWA 76126 (3) same as holotype.

Other material. New Zealand, Hikurangi Margin: NIWA 76138 (1) Stn E756, 42.02°S 174.44°E, 885 m, 30/03/1967; North Cape: NIWA 55513 (1) Stn TAN0906/83, 34.84°S 173.90°E, 136–138 m, 09/07/2009; NIWA 56813 (1) Stn TAN0906/164, 34.4°S 173.13°E, 145–149 m, 14/07/2009; NIWA 68427 (1) Stn F932, 34.44°S 173.12°E, 113 m, 15/10/1968. Macquarie Ridge, NIWA 40091 (1) Stn TAN0803/63, 52.48°S 160.41°E, 350–560 m, 09/04/2008; NIWA 68413 (2) Stn E228, 54.68°S 158.91°E, 148 m, 24/02/1965; NIWA 76250 (1) Stn C732A, 54.49°S 158.97°E, 220 m, 25/11/1961.

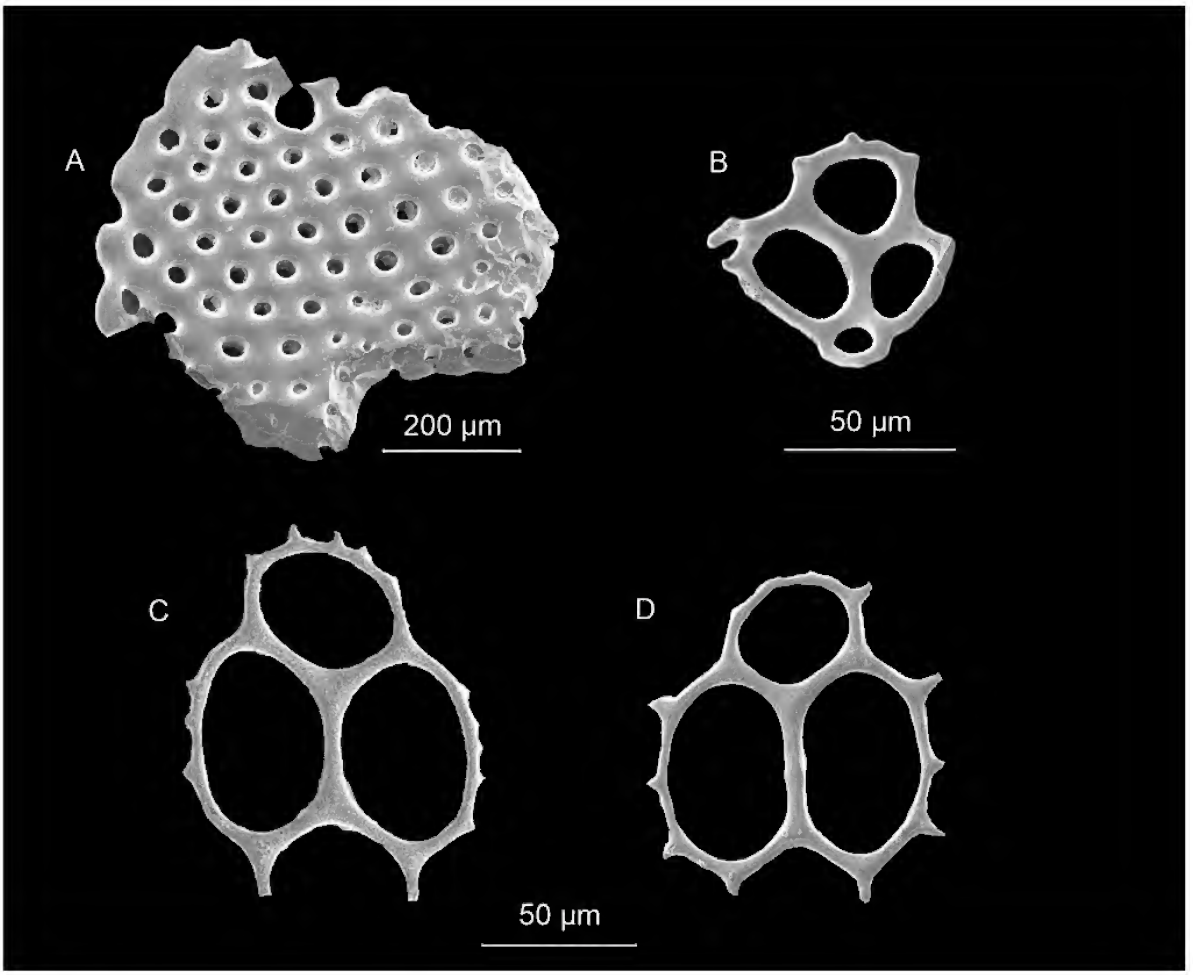

Figure 9. *Psolidium kermadeci* sp. nov. holotype (A–D, NIWA 72333): A, dorsal scale with tube feet perforations; B, dorsal curved support plate; C–D, ventral ossicles, thin-walled perforated plates with spiny knobs on margins.

Description. *Psolidium* species up to 16 mm long, 5 mm high, 8.5 mm wide. Profile moderately high, rarely flat, anal and oral ends commonly raised slightly. No distinct oral or anal valves or plates; these are a continuation of small body wall scales. Dorsal and lateral scales visible and continuous over body wall, up to 3 mm wide but most commonly 1.5–2 mm wide, covered in conspicuous fine granules. Ventral margin scales significantly smaller, reaching a maximum of 0.7 mm wide; two rows surround ventral margin. Dorsal and lateral tube feet can be seen under a microscope on some specimens.

Sole transparent, naked midventrally, peripheral series of large tube feet in 1–2 scattered rows that sit on ventral margin; smaller series of tube feet not present. Tube feet do not consistently extend onto midventral radius, but sometimes up to six tube feet can be clustered on the midventral radius posteriorly and anteriorly; feet a maximum of 0.25 mm apart.

Dorsal and lateral ossicles large multilayered plates (scales) up to 0.2 mm long with tube foot canals up to 40 μm wide, anastomosing, with secondary layering, thickening and/or heavy knobbing present marginally; single-layered plates with thickening, anastomosing and secondary layering also present, with few perforations, up to 190 μm long; tube foot support plates small thin, single-layered perforated plates with up to 18 perforations and up to 80 μm wide, plates curved up at opposing ends, perforations smaller on those upturned edges. Ventral ossicles single-layered perforated plates, surface generally heavily knobbed on one side, smooth on other surface, up to 24 perforations up to 125 μm wide, 2–4 larger central perforations (most commonly 2) with many smaller marginal perforations surrounding them, plate margins have blunt, rounded knobs; tentacle ossicles long rods up to 235 μm long, straight to curved to bent in shape, with

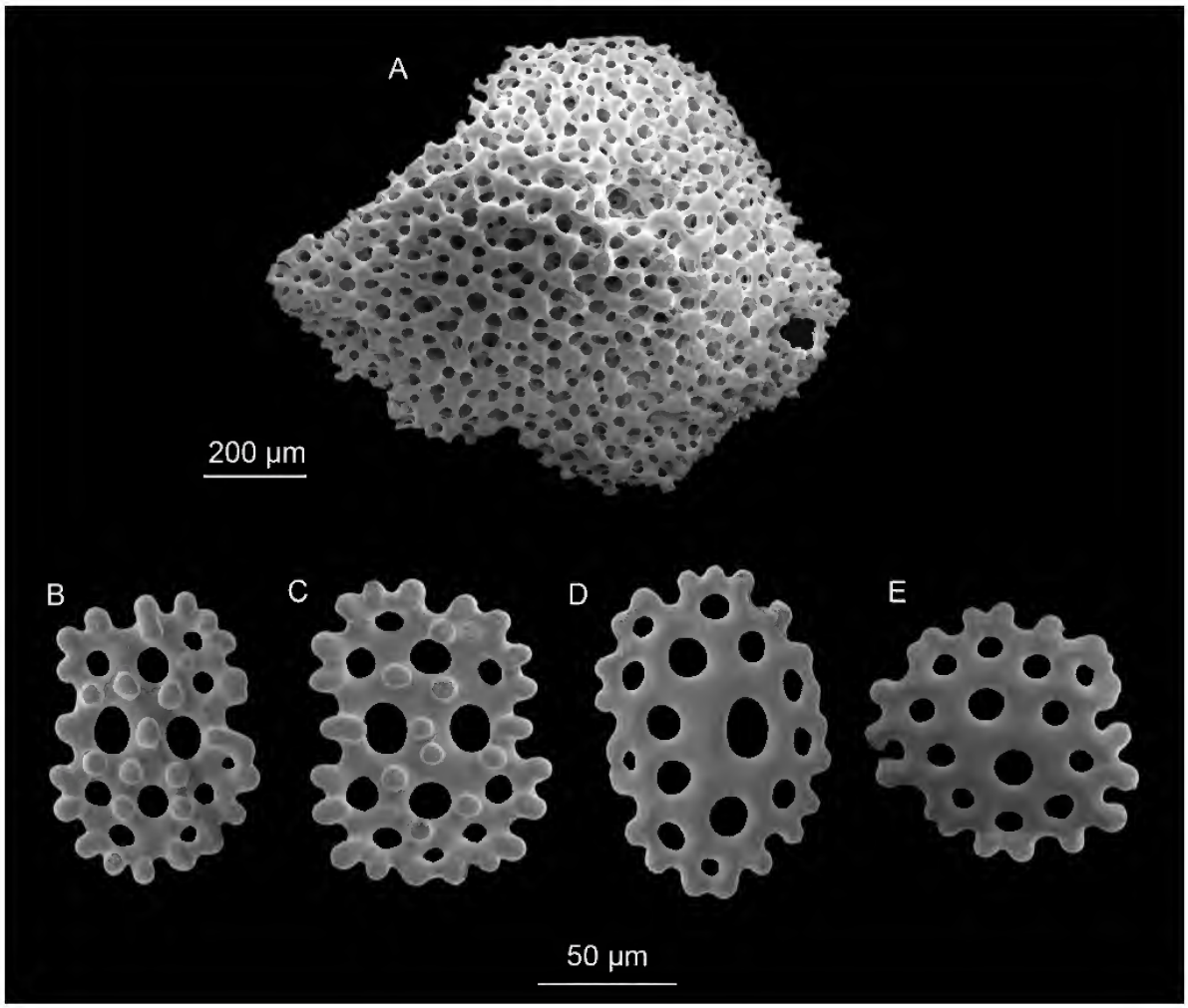

Figure 10. *Psolidium marriotti* sp. nov. (A–E, NIWA 40091): A, dorsal scale with tube foot perforations; B–E, ventral ossicles, knobbed plates with 2 main central perforations and numerous marginal perforations.

perforations at either end but not through the middle; small thin, single-layered plates, variably flat or curved to form a 'U' shape, up to 80 μm wide with up to 14 perforations; larger less curved single-layered plates up to 125 μm long with up to 12 thicker, larger perforations.

Colour. Preserved: dark to light brown with a grey to white margin around scales.

Distribution. New Zealand: Hikurangi Margin, Chatham Rise, North Cape; Macquarie Ridge; 136–885 m.

Etymology. Named for Peter Marriott, NIWA, who has provided the macro photos for this paper.

Remarks. *Psolidium marriotti* sp. nov. is similar to *Psolidium aequm* sp. nov., but is distinguished by the following characters: *P. marriotti* sp. nov. has an abundance of ventral ossicles, rounded and knobbed, with two larger central perforations and many small marginal perforations. In contrast, the ventral ossicles in *P. aequm* are sharper and more angular, with four larger central perforations. The tentacle rods of *P. marriotti* sp. nov. consistently have perforations through the middle and no blunt spines on the edges, whereas those of *P. aequm* sp. nov. only occasionally have perforations and always exhibit blunt edge spines. Additionally *P. marriotti* sp. nov. has no small, outer peripheral ventral tube feet. *P. marriotti* sp. nov. occurs at a shallower depth (135–885 m) than *P. aequm* sp. nov. (1040—1059 m), and it has a much greater geographic range, from New Zealand's North Cape southward to the Macquarie Ridge.

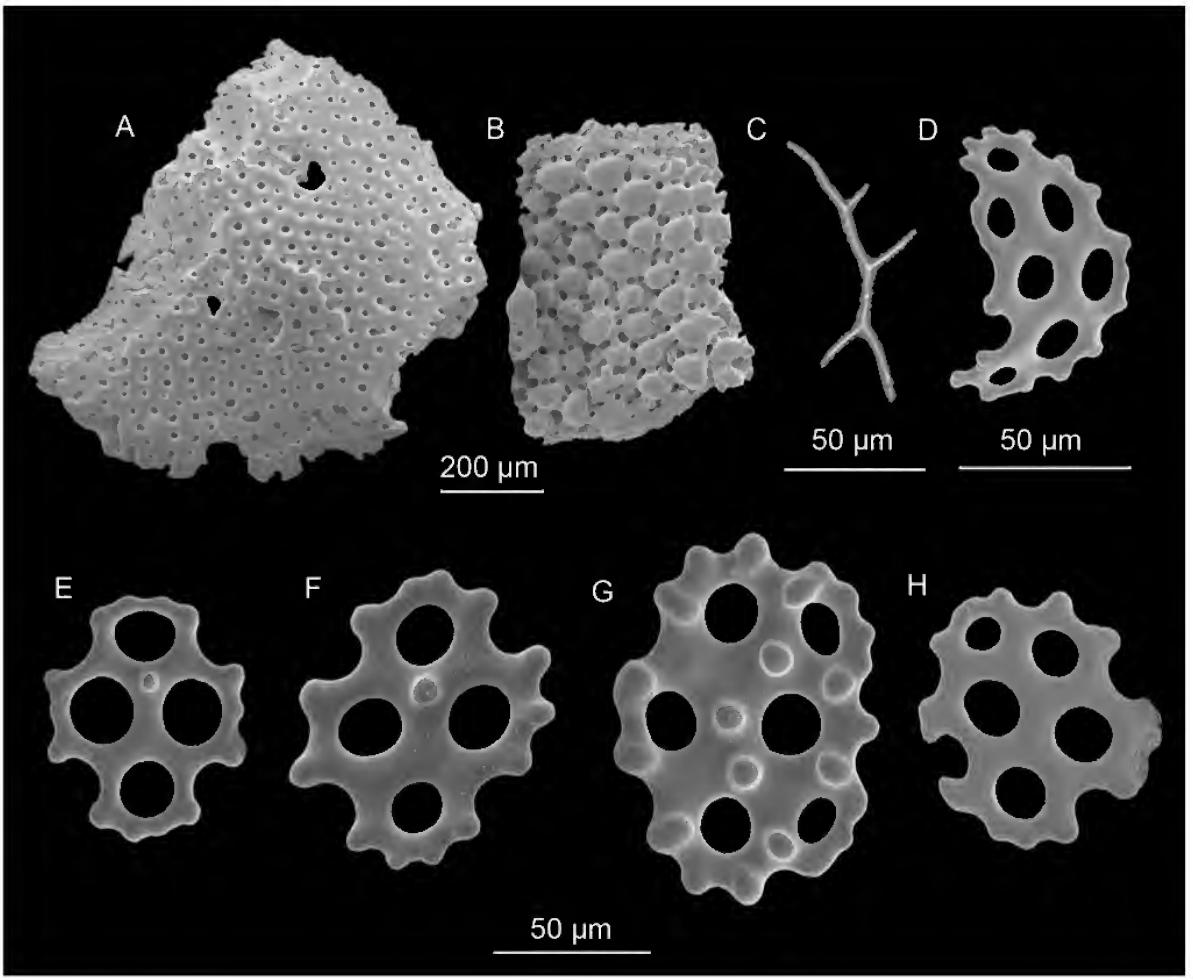

Figure 11. *Psolidium ramum* sp. nov. holotype (A–H, NIWA 73660): A–B, dorsal scales with tube feet perforations visible; C, thorn ossicle from dorsal body wall (also present in ventral body wall); D, curved tube foot support plate from dorsal body wall; E–H, knobbed plates with predominantly 4 even perforations.

Psolidium ramum sp. nov.

http://zoobank.org/urn:lsid:zoobank.org:act:A9BB906B-094B-4F5E-83C5-5FFD1C68CC9B

Table 1, Figures 2, 6A–B, 11A–H.

Material examined. Holotype. New Zealand, North Island west coast canyons: NIWA 73660 (1) Stn TAN1105/88, 36.18°S 173.68°E, 188–210 m, 01/04/2011.

Description. Psolidium species up to 16 mm long, 8 mm wide, 2 mm high. Profile low, body form oval. Oral cone slightly higher than anal cone; no distinct oral or anal valves or plates, approximately 230 μm wide, macroscopically smooth, microscopically glassy and beady texture, lacking significant bumps or pillars. Body wall dorsal and lateral scales macroscopically evident and continuous over body wall, up to 2.3 mm at widest point. Tube feet numerous, up to 10 per scale, evident throughout dorsal and lateral scales. Tentacles 10; 8 + 2 (ventral smaller). Sole largely destroyed, with peripheral single row of larger tube feet and smaller outer non-continuous ring of tube feet; midventral row of tube feet present, only 2 feet found as a result of a damaged sole.

Dorsal and lateral ossicles include large multilayered thick scales with small perforations and conspicuous round tube feet holes up to 60 μm in diameter; numerous tube feet support plates up to 85 μm wide; rare single-layered plates with 4–9 perforations up to 70 μm wide; broken thorn (branching rod) ossicles present.

Ventral ossicles knobbed perforated plates up to 100 μm wide with blunt marginal projections, predominantly 4 projections, sometimes more projections peripherally, and thick elongate plates up to 160 μm long, without knobs, with

small perforations; small crosses up to 60 μm wide; thorn ossicles present, mainly broken, largest 135 μm.

Colour. Preserved: white, with dorsal and lateral scales, grey centrally.

Distribution. New Zealand, North Island west coast, 188–210 m.

Etymology. The Latin word 'ramum' = branching, in reference to the branch-like thorn ossicles in the dorsal and ventral body wall of this species.

Remarks. This description is based on one specimen, of which the ventral sole was partially destroyed. The distinctive thorn ossicles, while rare, were present in both the dorsal and ventral body wall and have not been reported for any other New Zealand *Psolidium* species. In *Psolidium ramum* sp. nov. the ventral ossicles have predominantly 4 perforations; in *P. marriotti* sp. nov. they are numerous. *P. aequm* sp. nov. has larger perforations, thicker ossicles and many more angular knobs on ossicle margins. The thickened elongated plates are unique to *P. ramum* sp. nov. The northwest Australian species *P. parmatus* (Sluiter, 1901) and *P. nigrescens* Clark, 1938 also contain thorn ossicles similar to those of *P. ramum* sp. nov., but *P. parmatus* has bulbous pillars on the dorsal and lateral scales, and *P. nigrescens* is black, and has cups and crosses ventrally.

Further specimens would contribute to this description. The structure and distribution of ventral tube feet are difficult to determine, and there was little material available for ossicle extraction and SEM study. The tentacle ossicles could not be described due to the damaged state of the specimen, and these will need to be examined in the future.

Psolidium whittakeri O'Loughlin and Ahearn, 2008

Psolidium incertum.—Ludwig and Heding, 1935: 162–164, text-figs 28–29 (non-*Psolidium incertum* (Théel, 1886) = *P. poriferum* (Studer, 1876) (above).

Psolidium whittakeri.—O'Loughlin and Ahearn, 2008: 38, figs 3b–d, 8d–f.

Material examined. New Zealand, Hikurangi Margin: NIWA 63907 (1) Stn TAN1004/100, 42.13°S 174.54°E, 1375–1480 m, 24/04/2010; NIWA 63914 (1) Stn TAN1004/100, 42.13°S 174.54°E, 1375–1480 m, 24/04/2010. Kermadec Trench: NIWA 49868 (1) Stn TAN0413/40, 36.96°S 177.29°E, 1652–1669 m, 09/11/2004; NIWA 72086 (1) Stn TAN1105/27, 34.27°S 172.78°E, 66–67 m, 27/03/2011. Southern Plateau: NIWA 76139 (1) Stn E824, 46.97°S 166.54°E, 1217 m, 24/10/1967.

Description. O'Loughlin and Ahearn (2008) provide a recent and comprehensive description of this species. The material examined here concurs with this description.

Distribution. Antarctica, South Sandwich Island, South Shetland Island, Bouvet Island, 146–759 m; New Zealand, Hikurangi Margin, Kermadec Trench, Southern Plateau, 66–1669 m (this paper).

Remarks. *Psolidium whittakeri* O'Loughlin and Ahearn, 2008 is so far only known from the Southern Ocean around Antarctica. This current material has extended the range of this species around the Antarctic continent, as well as northwards into Subantarctic and temperate latitudes. Additionally, the reported depth range has been extended from 759 m to 1669 m at the more northern record (NIWA 49868).

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